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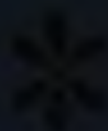
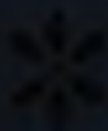
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LATERAL AND OTHER FORMS
OF
CURVATURE OF THE SPINE:
THEIR
PATHOLOGY AND TREATMENT.

LECTURES
ON THE
PATHOLOGY AND TREATMENT
OF
LATERAL AND OTHER FORMS
OF
CURVATURE OF THE SPINE.

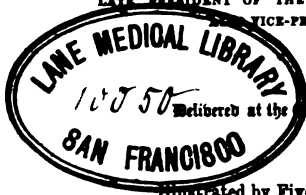
BY
WILLIAM ADAMS, F.R.C.S.

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LATE PRESIDENT OF THE HARVEIAN SOCIETY, AND OF THE MEDICAL SOCIETY OF LONDON;
VICE-PRESIDENT OF THE PATHOLOGICAL SOCIETY OF LONDON.



Illustrated by Five Lithograph Plates and Seventy-two Wood Engravings.



SECOND EDITION.

LONDON:
J. & A. CHURCHILL, NEW BURLINGTON STREET.
1882.

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1882

TO
THOMAS HODGKIN, M.D.

My Dear Dr. Hodgkin,

In presenting the present work to the profession I gladly avail myself of your kind permission to dedicate to you the result of my labours, with the grateful remembrance that it was through your recommendation I received the appointment of Demonstrator of Morbid Anatomy and Curator of the Museum at St. Thomas's Hospital, in the year 1842, when in conjunction with Mr. R. D. Grainger, Dr. Marshall Hall, Dr. Gregory, Dr. Meryon, and with the valuable assistance of the late Joseph Henry Green, you undertook to regenerate the school of St. Thomas, the rapid increase of which from that date bore ample testimony to the success of your efforts.

At this period, when you filled the chair of Practice of Medicine and General Pathology, I had in the discharge of my duties, and by your able assistance, the means of acquiring a practical knowledge of pathological anatomy

which has since enabled me to investigate with greater satisfaction and completeness the many diseases which come under the notice of the Surgeon.

But whilst alluding to the valuable assistance you afforded me personally, I must not pass over in silence the great obligations which by your published lectures and clinical teaching, the cause of medical science has incurred at your hands.

Under all these circumstances I cannot but feel a considerable degree of pride in associating my name with one whose public and private efforts, in connection with many philanthropic and learned societies for the social improvement and advancement of his fellow creatures, give him so much claim upon public gratitude ; and whose friendship it has been my privilege to enjoy for more than twenty years.

*Allow me to subscribe myself,
My dear Dr. Hodgkin,
With every sentiment of respect and esteem,
Your sincere friend and former colleague,
W. ADAMS.*

December 8th, 1864.

NOTE
TO
THE SECOND EDITION.

The second edition of the present work has been long called for, and I regret the call should not have been responded to at an earlier date; but my attention has been occupied by other work, which in the meantime has issued from the press. Probably, however, this interval may tend to increase the value of the present edition, which has undergone a thorough revision by myself and also by my friend and colleague, Mr. F. R. Fisher, upon whom much of the additional labour of conducting the work through the press has devolved. My warmest thanks are therefore due to Mr. Fisher for the valuable aid and assistance he has afforded me.

The views of recent authors have been referred to in notes added to the text, and a portion of the Appendix to the present edition has been especially devoted to the consideration of the relative merits of the treatment by suspension combined with the plaster-of-Paris jacket introduced by Professor Sayre; the poro-plastic felt jacket in which Cocking's poro-plastic felt is now used, and which Mr. Fisher has done so much to bring before the notice of the profession, especially in the treatment

of Pott's disease of the spine; the improved spinal instruments; and gymnastic exercises combined with recumbency. In this review I have embodied the results of long experience in the older systems, with careful observations and practical experience in the new methods which have attracted so much attention within the last few years. The relative merits of each system, and the extent to which they can be advantageously combined in the different classes of cases, have been carefully considered.

In the Appendix I have also reprinted from the "Medico-Chirurgical Transactions" a paper written by the late Dr. Hodgkin and myself, with a description of the case, and specimen from which the illustrations in Plates III., IV. and V. are taken. This case is especially interesting, as being the first which directed my attention to the subject of rotation of the bodies of the vertebræ in lateral curvature of the spine, in the year 1852.

The illustrations in the present edition have been increased by eleven new woodcuts, carefully executed by Mr. Sachs.

Henrietta Street, Cavendish Square,

December 3rd, 1881.

PREFACE
TO
THE FIRST EDITION.

The Lectures contained in the present work were delivered at the Grosvenor Place School of Medicine in the session 1860-61; and most of them were shortly afterwards published in the *Medical Times and Gazette*, from August 31st, 1861 to June 7th, 1862.

Four unpublished lectures have, however, been incorporated, with the view of rendering the subject more complete in all its details. The entire series has been carefully revised, and such additions made as experience enabled me to add.

In the year 1854 I delivered a special course of lectures on orthopædic surgery at the Grosvenor Place School of Medicine; and it was my custom annually to give a few lectures on orthopædic subjects, in the course of surgical lectures which I delivered, first in conjunction with the late Mr. George Pilcher, and subsequently with Mr. Spencer Wells.

In the present lectures the main object I have had in view has been to establish the treatment of spinal curvature upon a more exact knowledge of its pathology; and for this purpose it was necessary that I should be able to show the connection

between the external appearances presented during life, and the symptoms which accompany the severer forms of this deformity, with the appearances presented after death.

As spinal curvature contributes only indirectly to the death of the patient, by inducing, or aggravating, disease of the thoracic or abdominal organs, the opportunities of making post-mortem examinations in such cases must necessarily be rare. However, in the present lectures, I have appealed in support of the views brought forward, to such examinations; and also to the examination of various specimens preserved in the museums of London.

In reference to the treatment of these deformities, a comparison of the relative merits of the different systems, which have from time to time been advocated by various authorities, has to me always appeared of essential importance, with the view especially of determining the limits within which each system can be advantageously relied upon.

This portion of our subject, I have, therefore, endeavoured to investigate without prejudice, or exhibiting an undue partiality for any particular system; and if the conclusions arrived at should be considered as having contributed in any degree towards placing the treatment of spinal curvature upon a sounder and more rational basis than it has hitherto rested, it will never cease to be matter of congratulation and personal satisfaction that I entered upon the subject of this inquiry.

In conclusion, I am glad to take the opportunity of acknowledging the care bestowed by Mr. G. H. Ford in the faithful representations of spinal distortion in the Plates, Nos. II., III., IV. and V.; two of which Nos. III. and IV. have already appeared in the Transactions of the Med. Chir. Society, Vol. xxxvii, 1854. Plate I. has been drawn with equal care by Mr. Searson, of the Royal College of Surgeons, from specimens in the museum of the college; and for permitting these drawings to be made, my best

thanks are due to the museum committee of the Council of the College.

To Mr. Hart my acknowledgments are also due for the time and attention devoted by him to the execution of the majority of wood engravings in the present work.

Henrietta Street, Cavendish Square,
November 28th, 1864.

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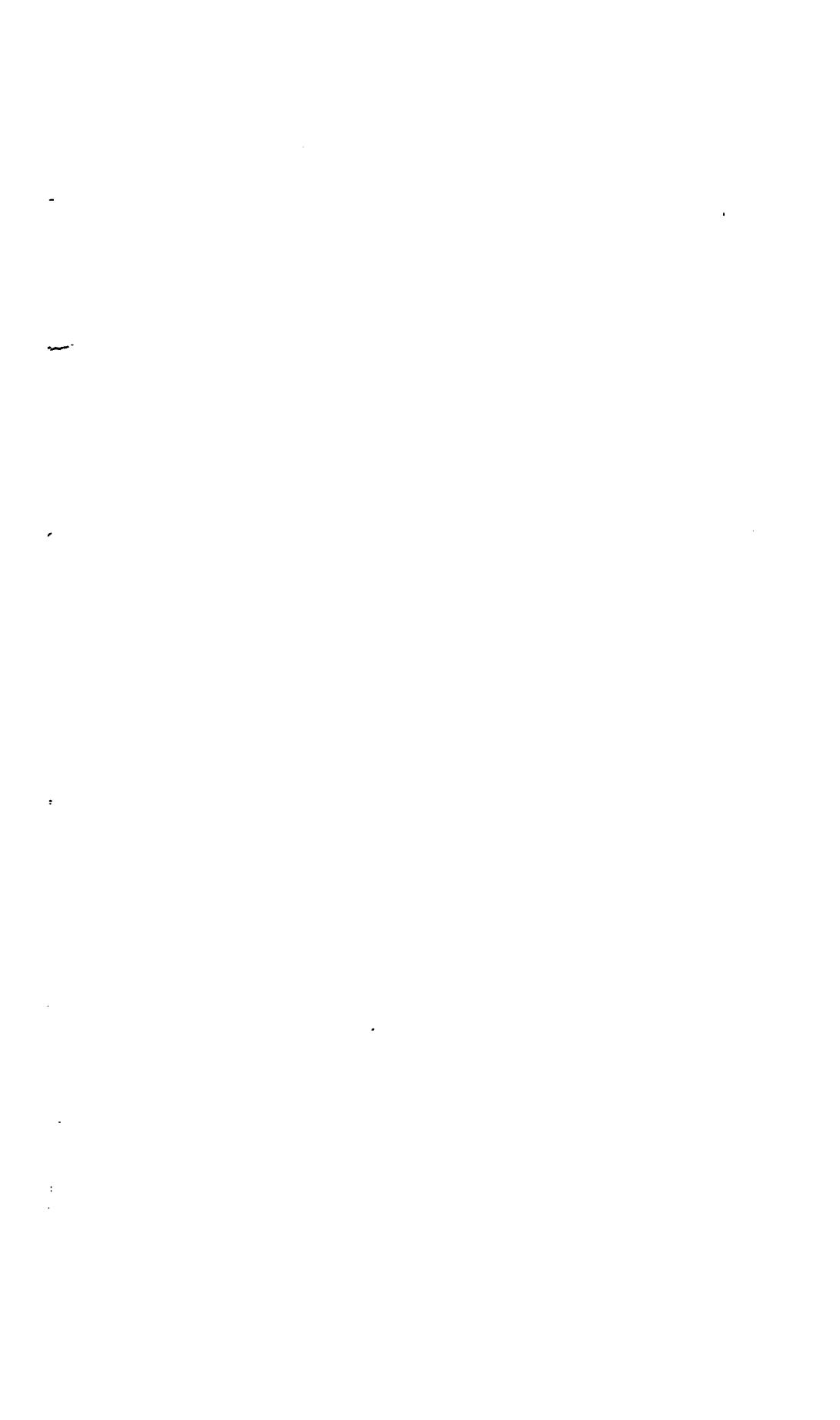
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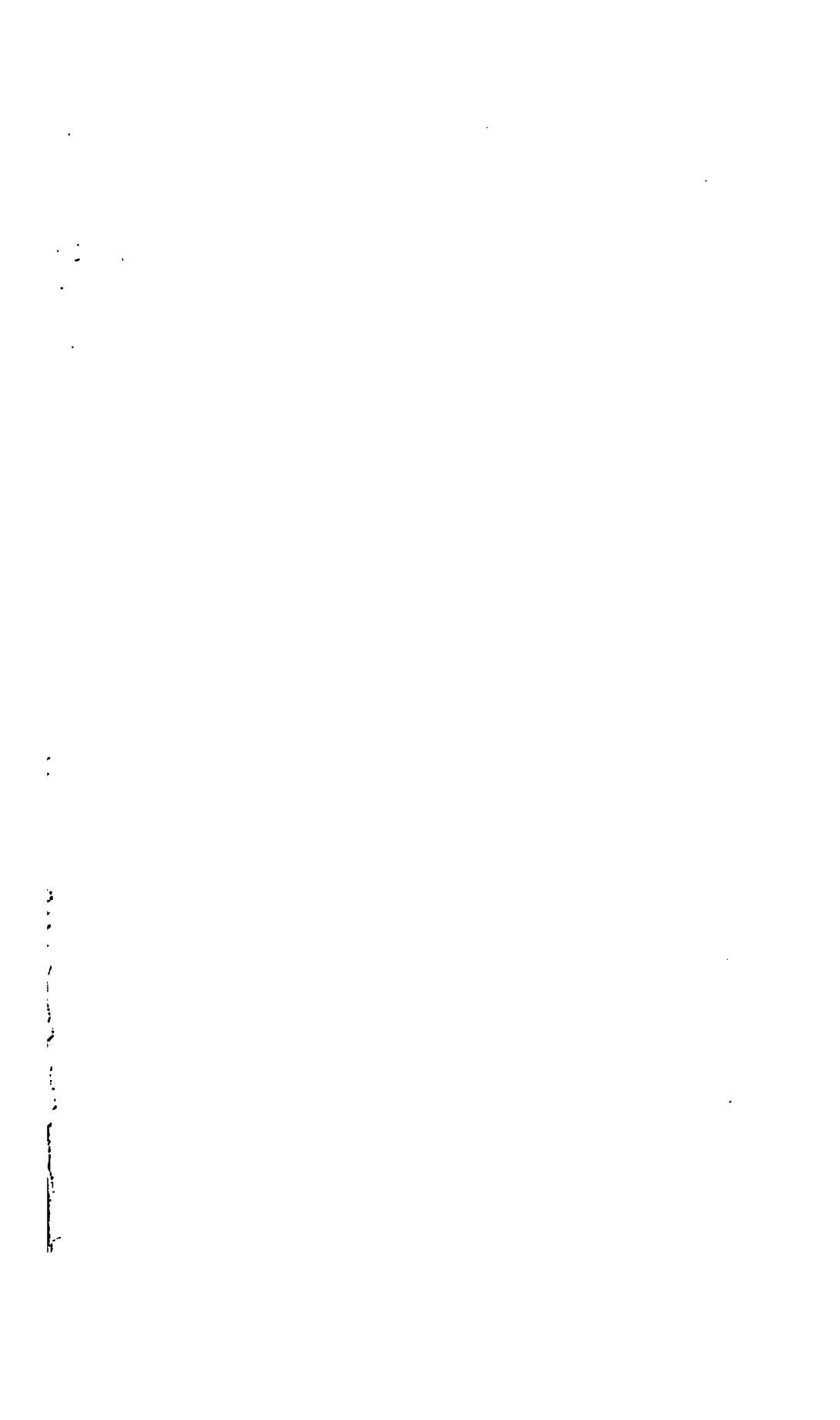
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PLATE V.

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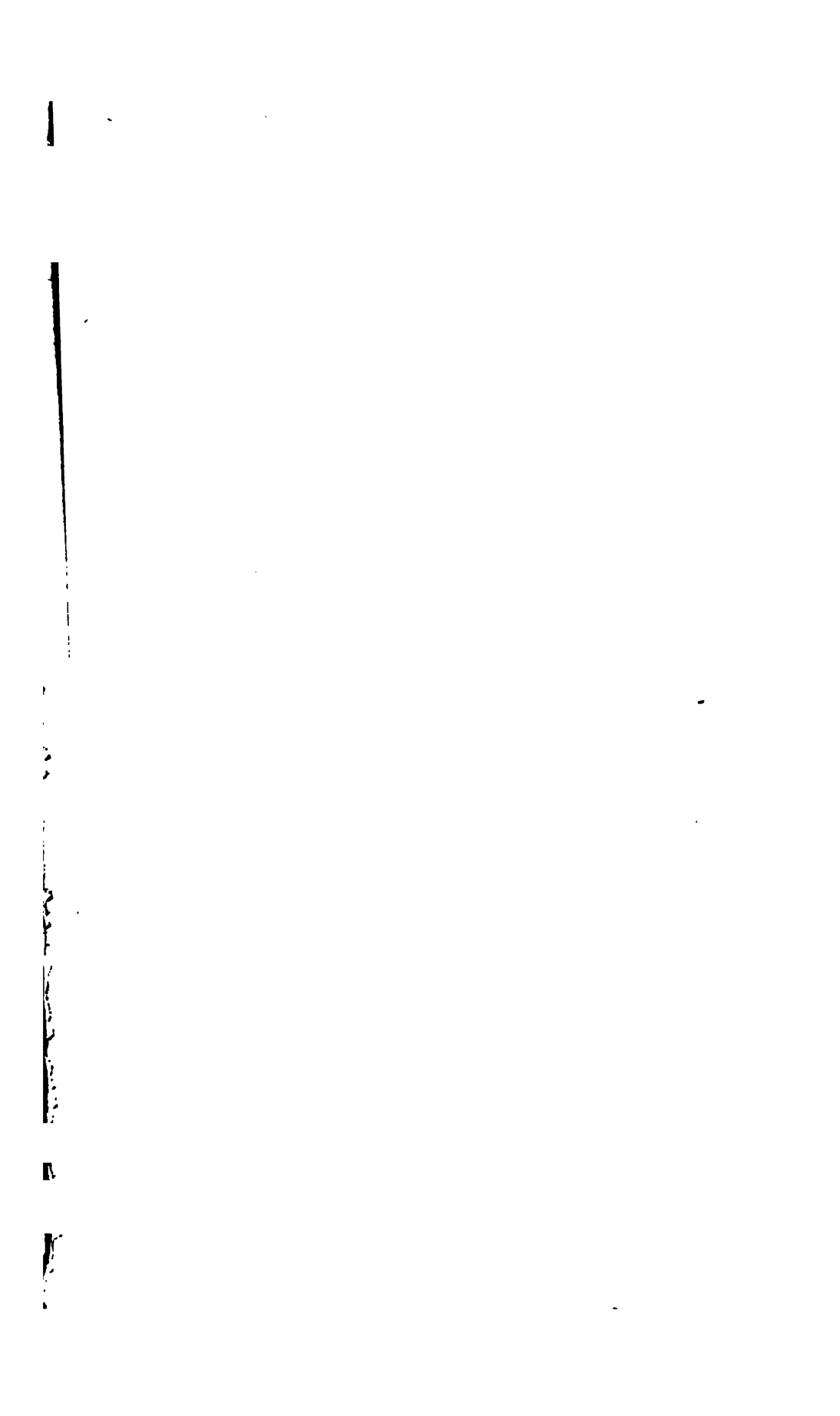




FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.



DESCRIPTION OF PLATE I.

HEALTHY ANATOMY OF SPINAL COLUMN.

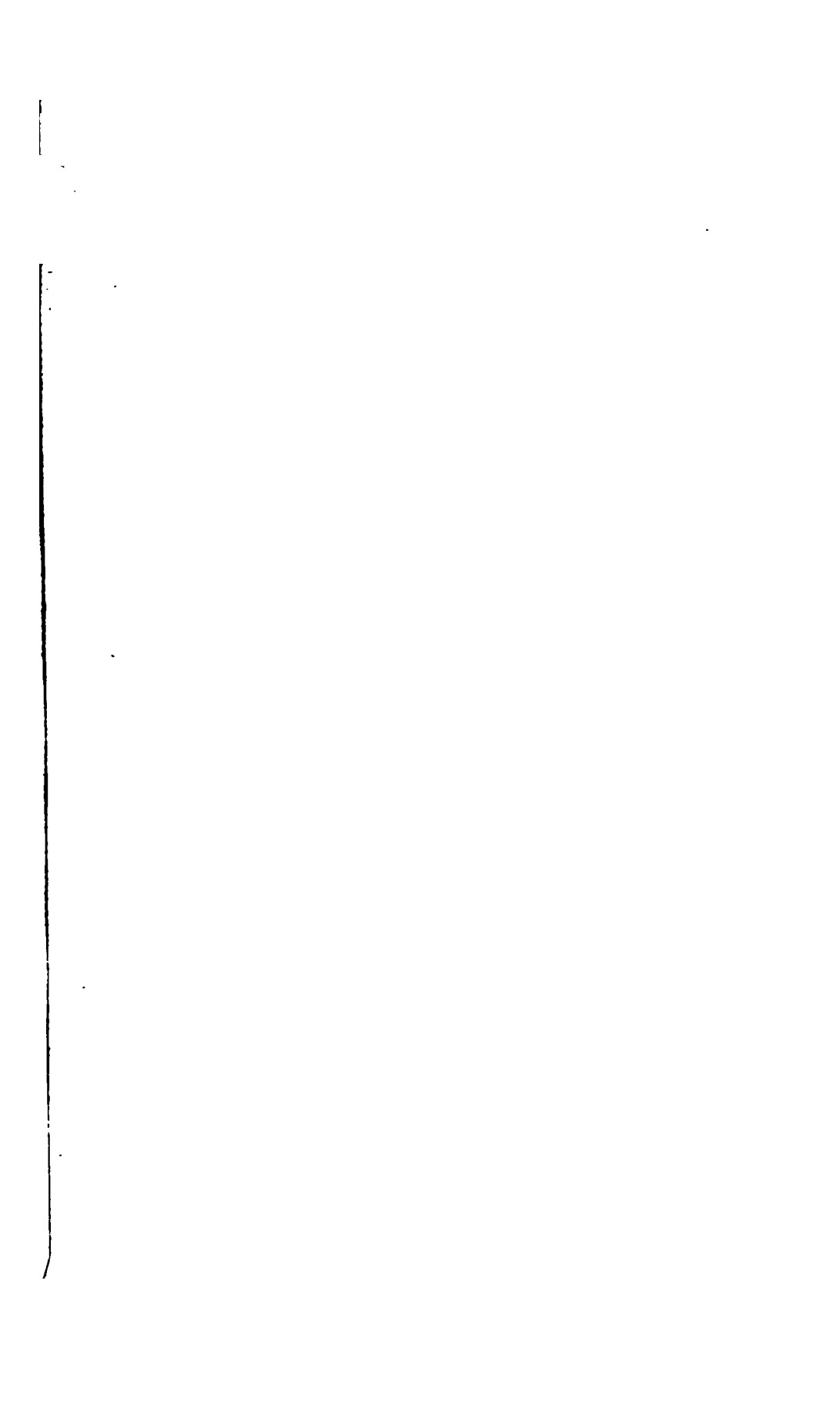
Fig. 1.—Section of spinal column of an adult, exhibiting the normal curves of the spine in the antero-posterior direction.—*See* page 14.

From a specimen in the Museum of the Royal College of Surgeons.

Drawn one-fourth the natural size, by Mr. W. Searson.

Figs. 2, 3, 4.—Drawings of the 5th cervical, the 9th dorsal, and the 2nd lumbar vertebræ, exhibiting the direction of the superior oblique articulating processes of each vertebra.—*See* page 28.

Drawn half the natural size, by Mr. W. Searson.



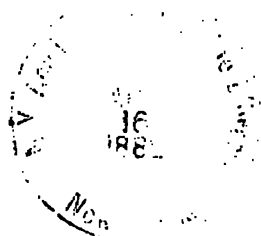


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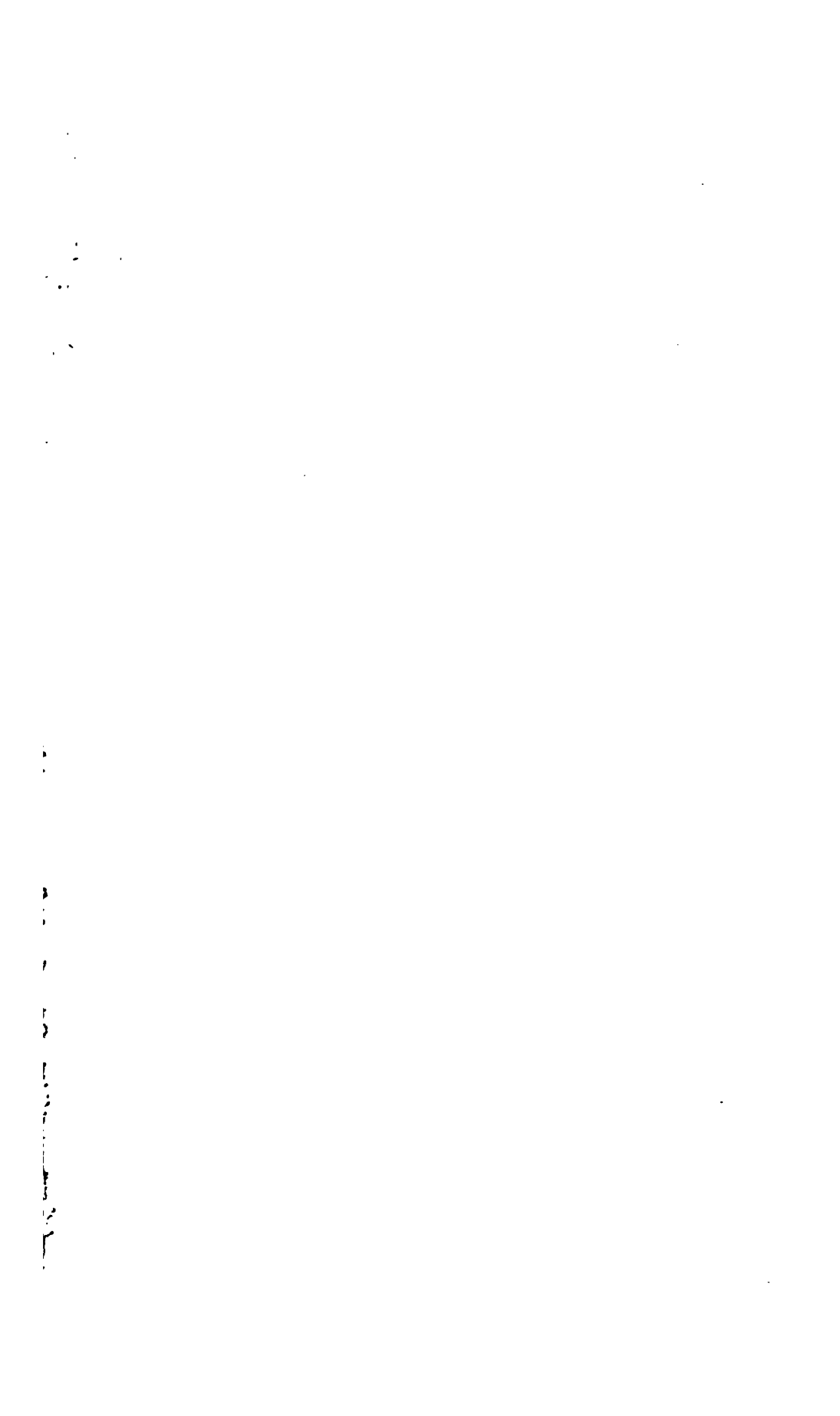
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Healthy Anatomy of the Spinal Column.

PLATE II.

Spontaneous Arrest of Lateral Curvature.

PLATE III.

Lateral Curvature in the Lumbar Region, with an extreme degree of rotation of the bodies of the vertebræ, and very slight lateral deviation of the apices of the spinous processes (posterior view).

PLATE IV.

Anterior Aspect of the same specimen as represented in Plate III., showing the extreme degree of rotation of the bodies of the vertebræ.

PLATE V.

Appearances presented on section of the Vertebral Column, from the same case as that represented in Plates III. and IV.



FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.



DESCRIPTION OF PLATE I.

HEALTHY ANATOMY OF SPINAL COLUMN.

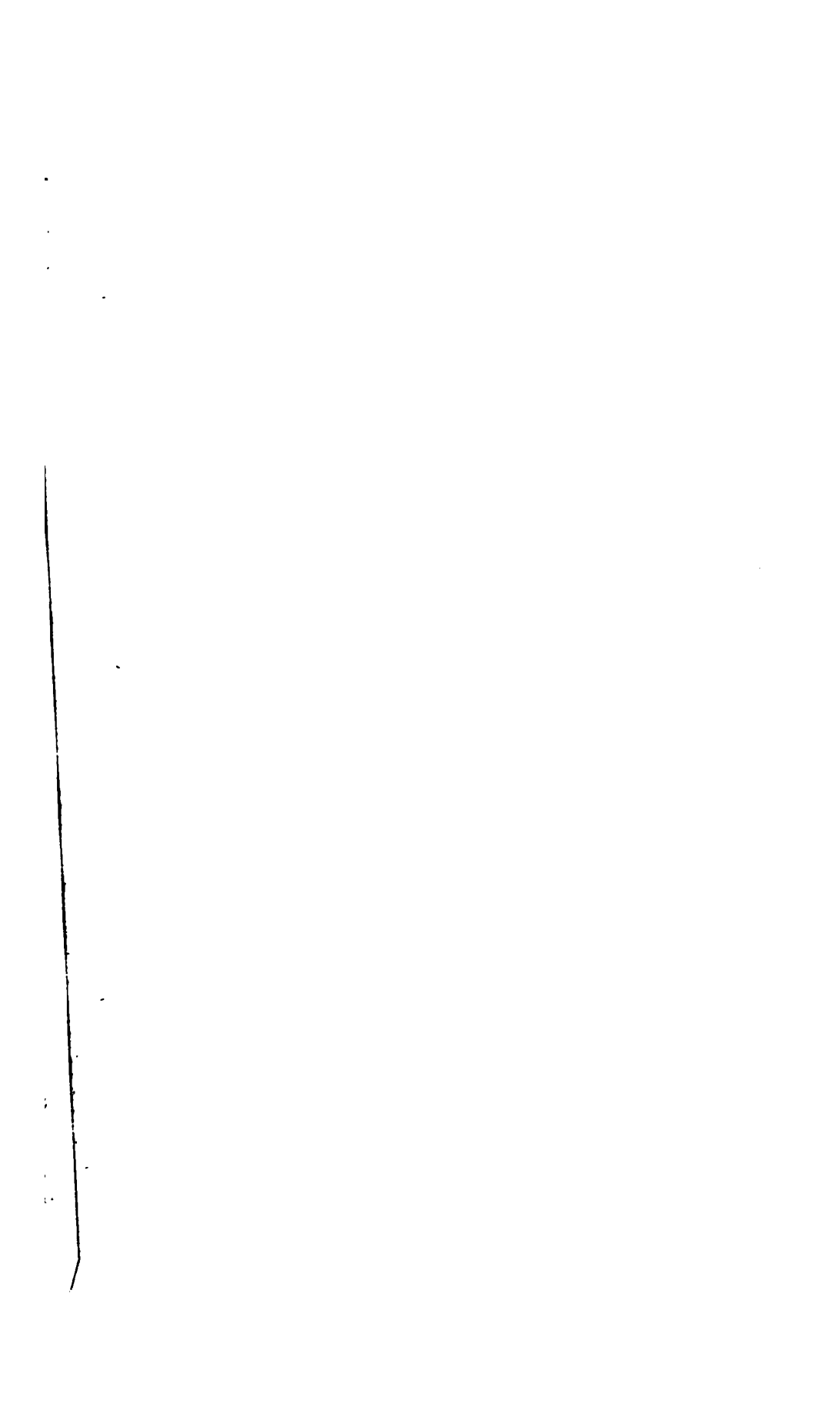
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From a specimen in the Museum of the Royal College of Surgeons.

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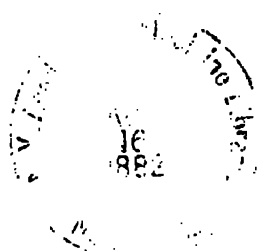
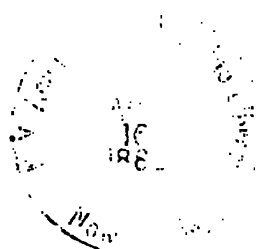


Fig 1



Fig 2



DESCRIPTION OF PLATE II.

SPONTANEOUS ARREST OF LATERAL CURVATURE.

In this plate, *Figs. 1 and 2* represent the external and internal appearances in a case of double lateral curvature which had undergone the process of spontaneous arrest as described at page 196. The disproportion between the external curvature of the spinous processes, and the internal curvature of the bodies of the vertebræ is also especially illustrated, in reference to the Diagnosis of Lateral Curvature as explained at page 203.

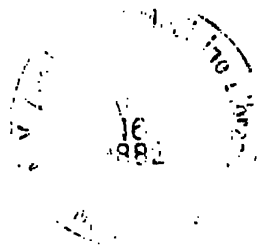
The specimen was removed from the body of a woman, aged 37 years, who died of cancer.

Fig. 1.—Posterior view, exhibiting very slight lateral deviation of the apices of the spinous processes to the right side, in the dorsal region. The ribs on the right side are more horizontal in their direction than those on the left; and the angles of the ribs together with the transverse processes on the right side are more prominent posteriorly than those on the left.

Fig. 2.—Anterior or internal aspect; exhibiting a lateral deviation of the bodies of the vertebræ in a very marked degree to the right side, in the dorsal region; and in a much less degree to the left side in the lumbar region.

In consequence of the compensative curves, by which the spontaneous arrest was affected in this case, which had never been submitted to any treatment for the spinal curvature, the bodies of the four vertebræ, viz.: the 3rd and 7th dorsal, and the 1st and 5th lumbar vertebræ, have suffered lateral compression on opposite sides, approaching to the wedge-like form, and are indicated by the letters *a. a. a. a.*







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DESCRIPTION OF PLATE III.

CASE OF LATERAL CURVATURE OF THE SPINE, WITH AN EXTREME DEGREE OF ROTATION OF THE BODIES OF THE LUMBAR VERTEBRÆ, AND VERY SLIGHT LATERAL DEVIATION OF THE SPINOUS PROCESSES EXTERNALLY.

The drawing in this plate represents the posterior aspect of the same specimen as in Plates IV. and V.

The apices of the spinous processes are seen to deviate but very slightly to the left side; whilst the bodies of the vertebræ presented internally an extreme degree of lateral deviation (better seen in Plate IV.) with horizontal rotation to the left side.

The transverse processes of the lumbar vertebræ on the left side projected posteriorly, so that their apices rose to the level of the apices of the spinous processes; and the transverse processes on the right side were depressed to a corresponding extent, as described at pages 84 and 100.

The transverse process of the 4th lumbar vertebra on the left side is seen to be flattened from above downwards, and also bent upwards in a horn-like form; and on the flattened and expanded extremity of this process, is seen an oval articular surface where it rested upon, and in a manner articulated with, the crest of the ilium. The transverse process of the 5th lumbar vertebra was sawn through in removing the specimen, but must have been more distorted than that of the 4th vertebra.

The oblique articulating processes are seen to be much altered in their direction and aspects. The articular facets instead of being nearly vertical, are very oblique in direction, and also present an irregular enlargement and nodulated appearance at the margins of the articular facets, as described at page 97.

A detailed description of the specimen, from which this and the two following plates are taken, will be found in the Transactions of the Royal Medical and Chirurgical Society, vol. xxxvii., 1854, in a paper on "A Case of Distortion of the Spine," by Dr. Hodgkin and Mr. Wm. Adams. This paper has been reprinted and added to the second edition of this work. See Appendix.



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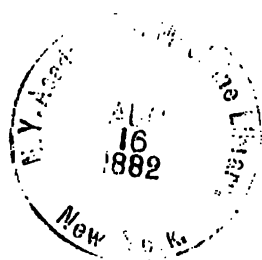
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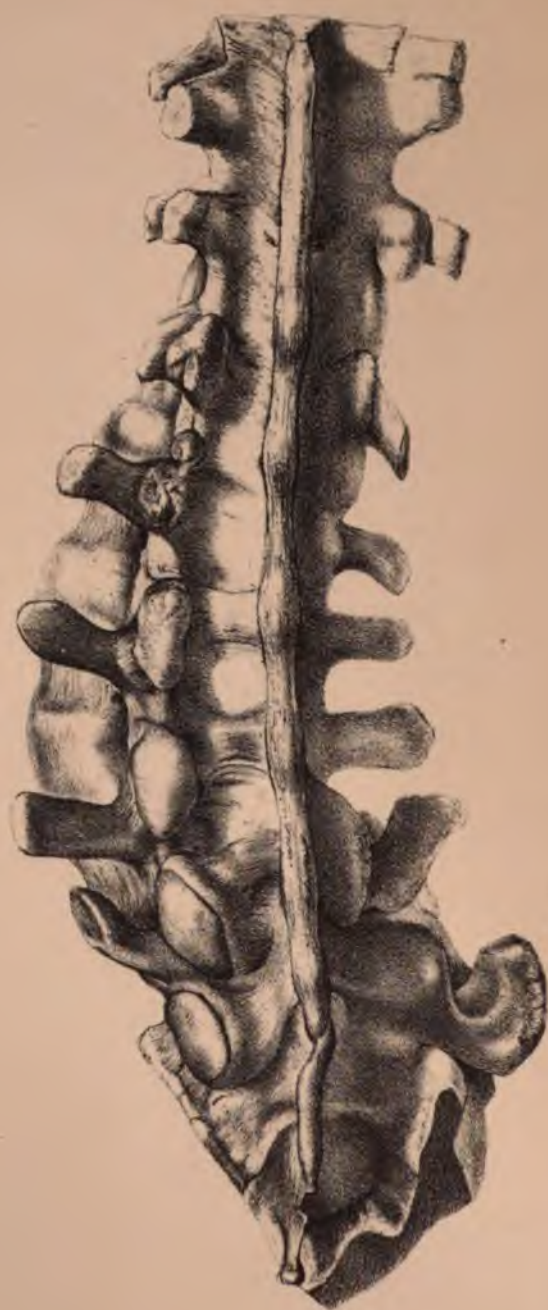
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CASE OF LATERAL CURVATURE OF THE SPINE, WITH AN EXTREME DEGREE OF ROTATION OF THE BODIES OF THE LUMBAR VERTEBRÆ, AND VERY SLIGHT LATERAL DEVIATION OF THE SPINOUS PROCESSES EXTERNALLY.

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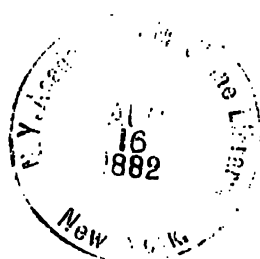
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DESCRIPTION OF PLATE IV.

LATERAL CURVATURE IN THE LUMBAR REGION, WITH AN EXTREME DEGREE OF ROTATION OF THE BODIES OF THE VERTEBRÆ.

The drawing in this plate represents the internal aspect of the same case as exhibited in Plates III. and V.

The portion of the spinal column involved in the curvature presents a spiral twist, rather than a true lateral deviation, the bodies of the vertebræ turning round in a direction of horizontal rotation, so that their anterior surfaces are directed laterally along the convexity of the curve.

In the present instance, this rotation-movement extends to a quarter of a circle in the centre of the curve, and diminishes from this point to the two extremities, as described at page 86.







DESCRIPTION OF PLATE V.

APPEARANCES PRESENTED ON SECTION BY THE BODIES OF THE VERTEBRÆ, AND INTERVERTEBRAL CARTILAGES, IN LATERAL CURVATURE.

The drawing in this plate exhibits the appearances presented on section from the same case as represented in Plates III. and IV.

The intervertebral cartilages have suffered most from unequal compression, and that between the 2nd and 3rd lumbar vertebræ has a wedge-like form, the cartilage having almost disappeared in the concavity of the curve. *See* description, page 95.

The bodies of the vertebræ have suffered from unequal compression to a much less extent than the intervertebral cartilages, and though reduced in thickness in the concavity of the curve can hardly be said to approach the wedge-like form.

In texture the bones do not present any unhealthy appearance, but the cancellous structure of the bodies of the vertebræ on the compressed side is increased in density, and at the inferior angles of the 2nd and 5th lumbar vertebræ, presents the appearance of a thickened layer, or mass of compact bone. These have been the points of the greatest pressure, as described at page 96.

In this drawing it can be seen that in the horizontal-rotation movement of the bodies of the vertebræ, there has been a certain amount of lateral sliding, or displacement of the body of the 3rd vertebra from the 4th, so that the lower border of the 3rd vertebra projects beyond the upper border of the 4th vertebra; and the body of the 4th lumbar vertebra, by a similar movement of lateral displacement, also projects beyond the body of the 5th vertebra. In the specimen each of these vertebræ projected beyond the one next below it three-eighths of an inch.

LECTURE I.

INTRODUCTORY AND GENERAL OBSERVATIONS—HEALTHY ANATOMY AND PHYSIOLOGY OF THE SPINAL COLUMN.

GENTLEMEN,—In commencing this course of Lectures I would briefly state as the reasons which have induced me to select for my subject the Pathology and Treatment of Curvatures of the Spinal Column—

1st. The fact that the most important of these various deformities, *lateral curvature*,* is an affection very commonly met with in this and all civilized countries; it is one which gives rise to very serious results, not only in the production of deformity, but in impairing the general health of the patient, either by causing severe local pain, or by interference with the functions of the thoracic and abdominal viscera.

2nd. The general neglect of this class of cases by the surgical authorities of this country, who, from their habits of pathological observation and large clinical experience, would be best qualified to establish the treatment of this affection upon a solid and scientific basis. This neglect may be satisfactorily explained by the fact that cases of deformity of the spine are seldom, if ever, admitted into any of the general hospitals of this metropolis. I do not believe that at the present time you would find a single case of lateral curvature of the spine under treatment in the wards of any hospital in London, though there are certainly some thousands of poor people in this metropolis, principally girls and young women, suffering not only from

* The term *lateral curvature* inaccurately expresses the precise nature of the curvature, but it is as well to retain it as it has been for so long, and is still so generally used.

unsightly deformity, but from seriously impaired health, consequent thereupon. The essentially chronic nature of the affection, and the great length of time required to effect permanent good by any system of treatment, almost necessarily exclude these cases from the benefit of hospital accommodation, which we know in this metropolis at the present time is very inadequate to the requirements of the population, even for the treatment of the more acute forms of disease. Hence you will perceive that the great metropolitan hospitals afford no opportunity of tracing the clinical history of this affection, or of practically testing the methods of treatment best adapted to the various stages and varieties of this deformity.

3rd. I have selected this subject because my connection since the year 1851 with the Royal Orthopædic Hospital, where these cases are treated in large numbers, has afforded me ample opportunities for clinical observation; and, moreover, because I have been enabled to investigate, by post-mortem examination, the condition of the spine in several cases of distortion.

For these reasons then, I have selected the subject of Curvatures of the Spine, and propose to lay before you the results of my investigations and clinical experience; and to explain the principles and details of treatment which I believe will be found best adapted to the different classes of cases, as they will present themselves to you in practice.

Lateral curvature of the spine, in an early stage, appears to be one of the most trivial and insignificant affections which the surgeon is ever called upon to treat, and too frequently do some medical men, who have had but little opportunity of watching the progress of such cases, look upon them with indifference, and confidently assure the parents that a slight prominence of the shoulder, or other deviation from a perfectly symmetrical form, which they may have observed in their daughter, is no more than exists in ninety-nine girls in a hundred throughout the country, and is of no importance whatever. This error, and the serious consequences sometimes resulting therefrom, will be hereafter adverted to.

Other surgeons, however, fully appreciating the importance

of such cases, and alive to the possibility of an unfavourable termination, give the same comforting assurances designedly, with the object of preventing their patients falling into the hands of empirics who still continue to engross to a great extent the spinal practice of this country; provided the medical men who adopt the latter course keep a watchful eye over these slight cases, and enforce such simple rules and preventive measures as we are all familiar with, I believe they take a wise and prudent course. In a large number of such cases nothing more will be required, but in other instances, as soon as the preventive treatment seems likely to fail, and increase of the affection becomes apparent, more specific treatment must be resorted to, because, trivial as slight spinal curvature may appear while as yet unaccompanied by pain, loss of health, or obvious external deformity, it is undoubtedly apt to become a most serious affection, leading to unsightly distortion and complete destruction of the general health.

Much of the importance which attaches to cases of lateral curvature in the early stage, arises from the extreme uncertainty which hangs over their future progress. We know that in some cases, without any treatment, spinal curvature may, in an early stage, undergo spontaneous arrest, no obvious deformity or interference with the general health resulting; and we are equally assured that in other cases the affection may increase, and produce not only external deformity of the most unsightly appearance, but also seriously interfere with the general health, either by the production of local pain, or by pressure on the lungs and heart, in consequence of increasing deformity of the chest, so that even life may be shortened.

Nothing can be more uncertain than the natural progress of a case of spinal curvature; and, therefore, whilst we are justified by the favourable termination and spontaneous arrest at an early period, in allaying the unnecessary alarm and anxiety sometimes evinced by over-anxious parents, it is our bounden duty to watch all such cases with a vigilance which will not allow the slow, insidious, and too often unobserved development of an affection, which having reached a certain point becomes

utterly incurable. I state this forcibly, because I have seen an incalculable amount of mischief result from surgeons giving the most positive assurances to parents that their daughters were perfectly straight, even when the cases exhibited an obvious disposition to pass into confirmed distortion.

I have already adverted to the absence of any facilities in the hospitals of this metropolis for the clinical study of cases of spinal deformity, in consequence, of such cases not being admitted as in-door patients in these institutions. The result of this is, that in the general progress of medical science, during the past century, comparatively little advance has been made in our knowledge of the causes, mode of production, and pathological changes in some cases of deformity of the spine; and it may certainly be said that lateral curvature of the spine has at the present time no fixed pathology, and as a necessary consequence, the principles of treatment are equally undetermined.

A little consideration of these facts will at once explain why cases of lateral curvature of the spine always have been, and still continue to be, treated upon the most opposite and antagonistic principles. It will be equally obvious to you that a continuance of this state of things necessarily leaves open a wide field to the pretensions of that class of irregular practitioners to whom I have before adverted. It cannot but be admitted, however, that the cause of the evil rests with the medical profession, and it is clear that we have the remedy in our own hands; so long as the pathology and principles of treatment of lateral curvature of the spine remain undetermined, we must cease to be surprised that the public, who are never slow to discover defects and uncertainties in medical practice, should believe—as one of the most able and scientific English authorities on spinal deformity, Mr. John Shaw, has observed—that “these unprincipled practitioners have secrets for the management of distortions with which surgeons are not acquainted,” and that the occasional success of the empiric after failure under the direction of an eminent surgeon, by means diametrically opposite to those previously recommended, should

“confirm a parent’s suspicion, that the knowledge of the *quack* is superior, in such cases, to that of the surgeon.”*

The treatment of spinal deformities, then, having remained chiefly in the hands of irregular practitioners, with nothing to guide them but their own observations of the most ordinary phenomena presented by these affections, we find what we might naturally expect, that these men always adopted one leading method of treatment, which, for the purpose of creating a speciality, each one endeavoured to elaborate into a *system* of his own, contrasting, as strongly as he was able to make it, with the so-called *systems* of his contemporaries, and reputed to be of wonderful and specific agency in the *perfect cure* of spinal deformities.

In this way a variety of the so-called *systems* of treatment for lateral curvature have sprung into existence, and have each in their turn enjoyed the sanction and support of public opinion; thus, treatment by means of complete recumbency, by the employment of gymnastic exercises, by cutting the spinal muscles, by mechanical extension, and by means of spinal instruments, are examples of different methods which have been devised and respectively advocated by different authorities on the treatment of curvature of the spine.

A review and historical sketch of the different systems, as applied to the treatment of deformities of the spine, would form a curious and not unprofitable chapter, but here I merely enumerate them as the necessary consequences of the absence of any fixed pathology, or scientific basis for rational treatment; and of the long-continued neglect of this class of cases by the profession.

It were, indeed, to be desired that these so-called systems could be spoken of only as things of the past—belonging to the reign of empiricism in medicine generally—but, unfortunately, they still exist; and the same spirit in which they were conceived still remains and influences the book-writing

* “On the Nature and Treatment of the Distortions to which the Spine and the Bones of the Chest are subject.” London, 1823. Also, “Further Observations on the Lateral or Serpentine Curvature of the Spine, &c.” 1825.

and book-advertising portion of those who, from their professional position, claim the right to be considered as authorities in this department of practice. Hence we see a spirit of antagonism still kept up between these different systems, the advocates of each decrying the advantages of the others as loudly as they extol their own; whereas, the truth lies, in a judicious combination of the different principles upon which these systems have been founded, or in a limited application of such methods to appropriate cases.

The remedy for this state of things seems now to be dawning through the thick clouds of professional neglect and popular prejudice, and let us hope that it will be effectual in removing this class of cases from the group which still form the *opprobria* of medical science. Since the treatment of deformities generally has been rescued from the hands of the empiric and the mechanician, and incorporated with the general practice of surgery—mainly through the discovery of the subcutaneous method of dividing tendons, by which so many of the severest deformities, such as club-foot, contracted knee, wry-neck, and the fascia in contracted fingers, may be speedily and safely cured—it has been found that the deformities of the body are so numerous and varied in their character and pathological peculiarities, and at the same time so imperfectly understood, that it has been thought desirable to group all cases of deformity affecting the limbs, spine, and other parts of the body in a separate class, and to create what is called a speciality, or special branch of surgery, for the cultivation of which special hospitals have been erected in various parts of the Continent, and more recently in this country.

Such institutions have been established with the expectation that when these cases are studied on a large scale, and by the light which they mutually reflect upon each other, their pathology and treatment may be more readily determined; and as the means employed to rectify such distortions have generally for their object the straightening of deformed limbs, most commonly occurring in children, the art of curing such deformities has been termed Orthopædy, from *ὀρθός* straight,

and *παῖδος* genitive of *παῖς* a child, a term first used by M. Andry, Dean of the Medical Faculty of Paris, who in the year 1741, published at Paris a work in two volumes on "Orthopædy; or, the Art of Preventing and Correcting the Deformities of the Body."

If, then, the public, in consequence of their recognising a great want and deficiency in the existing medical institutions of this country—the arrangements of which do not admit of the extension of their benefits to a class of cases requiring special attention and expensive mechanical appliances—have determined to erect and support Orthopædic Hospitals, it must be admitted that at the same time they impose grave responsibilities upon the surgeons of such institutions. The profession generally will look to the surgeons of these special hospitals for such an extension of knowledge as careful investigation and practical experience will necessarily lead to; they have also a right to demand their assistance in dispelling the fallacies with which special branches of medical knowledge are invariably surrounded. Our public professional appointments have their duties and responsibilities beyond the walls of the institutions in which we labour, and we fail to utilise such institutions, unless we make them schools of instruction, not only to those students who may have the opportunity of attending them, but also to the profession generally.

The great object I desire to keep in view in these Lectures will be to elucidate the general pathology of lateral and other forms of curvature of the spine, and in so doing establish the principles of treatment upon a rational and scientific basis.

Thus it will be clearly proved that lateral curvature of the spine may not only be produced by a variety of local causes, but that at the different periods of life at which it occurs, it is associated with such various constitutional conditions, that, instead of there being any one method or *system* of treatment applicable to all cases, as the advocates of each of those different systems to which I have adverted would have you believe, all the resources of medical and mechanical science are required either to cure or arrest the progress of this affection.

Now, gentlemen, before proceeding to the consideration of the morbid conditions of the spine in the deformities I am about to describe, let me first direct your attention to a few points in the anatomical construction and mechanism of the spinal column in a state of health.

HEALTHY ANATOMY.

Anatomical and Mechanical Construction of the Spinal Column.—The movable portion of the spinal column, above the sacrum, is composed of twenty-four vertebræ, the bodies of which, except the two first bones, are separated from each other by the intervertebral fibro-cartilages, through the medium of which it may also be said that the bodies of the vertebræ indirectly articulate with each other; but the bones are directly connected only by the oblique articular processes, the situation of which, posterior to the bodies and to the spinal canal, it is important to bear in mind, as we shall see that in various movements of the body in which the spine is bent sideways, the weight is thrown upon these articular processes, which are therefore liable to yield and become altered in form in the earliest stage of distortion of the spine. In the erect position of the body the weight is directly transmitted through the bodies of the vertebræ and the intervertebral cartilages, which, including that between the last lumbar vertebra and the sacrum, are twenty-three in number.

Relative Proportions of Intervertebral Cartilage and Bone in the Length of the Spinal Column.—It is unnecessary for me to describe anatomically the intervertebral cartilages, which you know are composed towards their circumference of thin plates of fibro-cartilage arranged concentrically, and in their central portions contain a soft, gelatinous-looking material. I need hardly remind you that it is upon the existence of this intervertebral substance that the elasticity and flexibility of the spine essentially depend; and as it is in this tissue that some of the earliest structural changes in spinal curvature take place, let us observe particularly how largely it enters into, and composes the length of the spinal column.

The average length of the adult spinal column, including the sacrum and coccyx, is stated by Professors Quain and Sharpey* to be "about two feet two or three inches;" and in reference to the relative proportions of bone and cartilage, the same authorities also state (page 189), that, "excluding from consideration the two first vertebræ, between which it does not exist, the intervertebral tissue forms in length about a fourth of the movable part of the column."

The brothers W. and E. Weber,† whose accurate investigations of the mechanism of motion at the various articulations of the human body have so largely contributed to our knowledge of this subject, carefully preserved the form of a spine by filling the cavities of the chest and abdomen with plaster of Paris, and then bisecting it in the median plane.

The exact relative proportion of cartilage and bone in this specimen, reduced to inches was :

Cartilage	3·8760165 inches.
Bone	17·6809075 „

In round numbers, then, according to the MM. Weber's calculations, we may say, that if the movable portion of the spinal column, *i.e.* from the sacrum to the atlas in which the intervertebral cartilages are contained, measures 22 inches, rather less than one-fifth of this length consists of soft elastic intervertebral cartilage.

My former colleague, Mr. Pittard, lately one of the anatomical teachers of this school, has been kind enough to make for me a longitudinal section of a spinal column in its recent state, and to measure very accurately the thickness of the bones and intervertebral cartilages. The following are the measurements in the spine. The height of the subject, a male, was five feet ten and a half inches :—

	Inches.
Total length of the spine above the sacrum (the measurement following the curves along the centres of the bones and cartilages.) . . .	23·6
Total length of the spine in a straight line, taken by a cord strained from the upper edge of the sacrum to the summit of the atlas . . .	23·1

* "Elements of Anatomy," page 18, Fifth Edition, 1842.

† "Mechanik der Menschlichen Gehuerkzenge," Göttingen, 1836.

	Inches.
Sum total of the thickness of the twenty-three intervertebral cartilages	
between the sacrum and the axis, measured through their centres .	5.9
Sum total of the thickness of the bodies of the twenty-four vertebræ, at	
their centres	17.7

In this specimen you will perceive that the relative proportion of the intervertebral cartilage to the bone was greater than existed in the specimen measured by MM. Weber. Of course a large number of spinal columns ought to be examined before any general statement can be made, but it would probably be correct to assume that about one-fourth, or between a fourth and a fifth of the length of the spinal column, above the sacrum, is composed of elastic intervertebral cartilage, and it is important for us to bear this in mind in reference both to the production and treatment of spinal curvature.

Compressibility of the Intervertebral Cartilage.—The effect of equal and unequal pressure upon this quantity of intervertebral cartilage is a point of the highest interest in reference to the mode of production of spinal curvature. Under the influence of equal pressure in the erect position of the body this intervertebral substance becomes compressed, so that during the day the body diminishes in height. Mr. Bishop* observes, "When the trunk has been kept in the erect posture during the day, an adult man, of middle stature, loses about one inch of his height, which he does not regain until after having remained some hours in a recumbent position."

The fact of variation in the height between morning and evening is well known to the recruiting sergeant, who measures his men in the morning. I have myself submitted the above statement to the test of experiment by means of an ingeniously constructed self-registering sliding measure, which was made for me by a young gentleman at Eton (himself the subject of spinal curvature), and which can easily be fixed to a door or any woodwork in a bedroom. By this contrivance he induced several of his school-fellows to register their heights night and

* "On the Pathology and Treatment of Deformities," page 37, by J. Bishop, Highley: 1852.

morning; I have also obtained numerous observations of the same kind, from which it appears that the average loss in height during the day in young and growing persons, as well as in adults, varies between half and three-quarters of an inch. It is sometimes a little above this, but I have not ascertained it to be a full inch in any instance.

There can be no doubt that this diminution in height is entirely due to the compressibility of the soft intervertebral substance; it is not probable that the thin layers of dense articular cartilage in the hip, knee, and ankle-joints, would suffer from compression, especially when we consider the rest which they obtain in the varied positions of the body during the day.

Average Length of the Spine as compared with the Height of the Individual.—From a careful measurement of fourteen adult skeletons in the Royal College of Surgeons, including the skeletons of the Irish and American giants, and the Sicilian dwarf, as well as those from the Bushmen, Negro, Polynesian, and Australian races, I have found that the average length of the spine—*i.e.*, taking its vertical height from the top of the atlas to the upper surface of the sacrum—forms as nearly as possible one-third of the total height of the skeleton. In seven instances this relative proportion was exact; in five, the spine was half-an-inch in excess; in one, an inch in excess; and in one half-an-inch less.

When measured along the anterior surfaces of the bodies of the vertebræ, the length of the spine will be found to exceed by from one to two inches the proportion of one-third of the total height of the body, this excess being due to the curves of the column. The spine then varies in length according to the height, but in well-formed individuals always maintains the relative proportion of one-third to the total height; this may be proved by external measurements, the anterior superior spinous process, which may be assumed to correspond to the upper surface of the sacrum, and the floor of the meatus of the ear, which corresponds to the base of the skull, being taken as the points for ascertaining the length of the spine.

This regular variation in the length of the spine in comparison with the height of the individual—the relative proportion remaining as one-third—is quite consistent with the popular observation so generally made, that the difference in height between tall and short people depends much more upon the length of the legs than of the spine, obviously because the spine forms only one-third of the total height of the individual; hence, the difference in height is noticed much less in sitting than in the standing position. This observation appears to have led some authors erroneously to think that to whatever extent people may vary in height the spine in all remains about the same length.

With regard to *the relative proportions of the trunk and the lower extremities in dwarfs and giants, as well as in short and tall individuals*, there can be no doubt that considerable variations often exist, though not to the extent generally supposed, as is shown by the measurements of the skeletons above referred to; but it by no means necessarily follows, as has been assumed by Mr. A. Shaw,* that in dwarfs, as a rule, there is a disproportionate shortness of the legs, and that “the proportions of the dwarf, therefore, correspond with those of the individual affected with rickets,” or that, in consequence of a disproportionate leg development, “the tall individual becomes a true caricature of the mature form.”

The measurements of fourteen skeletons above quoted, as confirmed by our daily experience, teach us that well-proportioned tall and short people—as well as their extremes, giants and dwarfs—are not infrequently met with, though I am not prepared to deny that tall people often exhibit a disproportionate length of legs, and short people a disproportionate shortness of the legs; and to some extent these deviations exist, perhaps in the majority of cases, but the statement has been made much too broadly. Moreover, in short people who exhibit this disproportionate shortness of the legs—and a long body and short-legged appearance is very common in short people in this

* “On the Conformation of the Skeleton in Rickets,” in the *Medical and Chirurgical Transactions*, vol. xii, p. 457. London, 1832.

country—I believe we may generally trace this peculiarity of conformation to a tendency to rickets, exhibited during the active period of growth and ossification in infancy and childhood, arising from imperfect lactation, upon which I believe, rickets more frequently depends than upon any constitutional defect from birth, or hereditary taint.

In addition to the shortness of the legs, other well-known characters of the rachitic skeleton often exist in a marked degree, and are evidenced by the peculiar form of the skull and features, as well as the large size of the epiphyses of the long bones, the form of the hands and feet, &c., and without doubt these characters generally exist with sufficient distinctness to enable us to trace the rachitic tendency as a cause of the dwarfishness.

Some explanation of this defect in the relative proportions of the trunk and lower extremities in the rickety skeleton will be found in the valuable paper by Mr. A. Shaw, "On the Conformation of the Skeleton in Rickets." By a comparison of the rachitic conformation with the relative proportions of the figure during growth, from foetal and infantile life to adult age, which Mr. Shaw has given in a tabulated form, it appears that the disproportionate shortness of the legs, which is one of the most marked peculiarities of the rickety skeleton, may be regarded as a persistent conformation of the skeleton in foetal and infantile life produced by the influence which rickets has in retarding the growth of the entire skeleton; and that the arrest of growth being more strikingly exhibited in the lower extremities, is to be accounted for by the fact that naturally the process of development is more active in the lower extremities than in the superior division of the body, after birth, so that when the child becomes the subject of rickets, instead of the legs gaining in length at their normal rate, they grow only at the slow rate of the rest of the body.

I have perhaps digressed too far, but there is a practical as well as scientific interest in these views which I felt desirous of bringing under your notice.

Pyramidal Form of Spine.—The spinal column, thus con-

stituted in its length of bone and intervertebral cartilage, presents when viewed anteriorly a pyramidal form, the expanded base of which rests upon the upper surface of the sacrum. When the sacrum and coccyx are considered as portions of the spinal column, the form of the latter is properly described as consisting of two pyramids with their bases meeting at the junction of the sacrum with the last lumbar vertebra; however, when speaking of the spine for surgical purposes we include only the true vertebræ above the sacrum.

The pyramidal form of the spinal column is rendered slightly irregular, by a little narrowing laterally in the upper dorsal region, but still, as Bishop* observes from MM. Weber's calculations, "the areas of the articulating surfaces of the bodies increase from the second cervical to the last lumbar vertebra, so that the surfaces of the bones increase as the weight they have to sustain augments," and the mean diameter of the intervertebral cartilages, which I presume would correspond to the mean diameters of the bodies of the vertebræ in the same regions, is stated to be as follows† :

Cervical = 15·0
Dorsal = 25·3
Lumbar = 28·0

I need hardly observe that the pyramidal form is mechanically that which most securely provides for the stability of the spinal column in the erect position.

Normal Curves of the Spine.—Antero-posterior Curves.—The spinal column, including the sacrum, when viewed in profile, as exhibited in Plate I, Fig. 1,† presents four curves, directed alternately forwards and backwards, corresponding to the outline of the body which it determines. In the neck and loins the convexity is directed forwards, and in the back and pelvis it is in the opposite direction. The dorsal curve increases the capacity of the chest, and the lumbar curve is necessary to bring the thorax more directly over the base of support.

* *Op. cit.*, page 36.

† *Op. cit.*, page 34.

‡ Copied from a specimen in the Museum of the Royal College of Surgeons, by Mr. W. Searson.

It is not, however, for me to dilate upon the physiological advantages of the curved form of the spine, but in reference to the mechanical advantages or disadvantages of this curved form, I think there can be no doubt of the accuracy of Mr. Bishop's observation—in opposition to the statement of Rollin and Majendie, who, he tells us, considered the spine in its curved form to be sixteen times stronger than if it were straight—that “so far from being stronger in consequence of being originally bent into several curves, the spine is, in fact, much weaker, and the greater the radius of curvature at any point of the axis, the less will be the strength.”* Mr. Bishop also shows that the sixth and seventh dorsal vertebræ, which are the most remote from the vertical line which passes nearly through the axis of the occipito-atloid and sacro-lumbar joints, must resist a weight placed on the head with the least mechanical advantage, hence “when the spine is mechanically incurvated in the mesial plane, it is so most commonly at this part.” This also explains the prominence of two or three of the lower dorsal spinous processes which we frequently observe in growing girls with weak spines, a condition which is too often made the cause of unnecessary alarm, under the supposition that it indicates the existence of a more serious affection.

Mode of Production of Normal Curves.—From the very accurate measurements of MM. Weber, it has been proved that the cervical and lumbar curves are occasioned principally by the unequal heights of the anterior and posterior portions of the intervertebral cartilages, and the dorsal curve chiefly by the wedge-like figure of the bodies of the vertebræ, although, as Mr. Bishop observes, it appears from Weber's table that “the cartilages, as well as the bones, are thicker at the posterior part in the dorsal region.”†

Existence of Lateral Curves as a Normal Condition?—The existence or non-existence of any lateral deviation of the spine as a normal condition, is a subject of some importance in reference to the production of lateral curvature. Professors

* *Op. cit.*, page 34.

† *Op. cit.*, page 34.

Quain and Sharpey state*—"A slight degree of lateral curvature is also observable in most cases in the dorsal region, the convexity of which is directed towards the right side. The older anatomists imagined this to be produced by the action of the aorta beating against the left side of the column; but Bichat attributed it to the effect of muscular action," that is, to the excessive use of the right arm. "Béclard has stated that he found in one or two individuals who were known to be left-handed, the convexity of the lateral curve directed to the left side. A further confirmation of the correctness of this view is afforded by an observation made by Professor Otto.† In a case in which the aorta arched to the right instead of the left side, he found that the curve of the vertebral column had the usual direction; so that the great vessel was connected with its convexity. It is stated, too, that the right arm was more muscular than the left."

Dr. Little,‡ gives the following abstract of the opinion of Bühring on the subject, in connection with his views explanatory of the origin of lateral curvature from its prototype, a physiological state:—"Bühring§ confirms the observations of Desruelles, Petrequin, and Hyrtl, that in the healthy and robust, besides the normal antero-posterior curves, a distinct thoracic curve of the spine to the right exists. This is attributed to the spinal column being unequally loaded at the sides in different parts,—on the left, in the dorsal region, by the heart and great blood-vessels, and on the right by the liver. The ordinary dorsal curve in lateral curvature he proposes to term '*cardiac curve*,' and the ordinary lumbar curve, '*hepatic curve*.'

Besides the mere effect of relative overloading of the column, Bühring, remembering the influence exercised during the de-

* *Op. cit.*, page 18.

† "Seltene Beobachtungen, Th. 2, s. 61. See also "The Anatomy of the Arteries with its applications to Pathology and Operative Surgery," by R. Quain. Page 19.

‡ "On the Nature and Treatment of Deformities," page 367. London, 1853.

§ "Die seitliche Rückgrats-Verkrümmung." Von Dr. J. J. Bühring. Berlin, 1851.

velopmental period by the arteries upon their contiguous parietes, even when bony, is of opinion that the heart and aorta obtain an increase of space by impelling the dorsal vertebræ to the right; whilst the liver and its vessels similarly dispose to the lumbar curve." Dr. Little, in stating his own opinion, adds, that whilst "he is not prepared to deny that a curve requiring a more precise measure of a straight or curved line than the eye can appreciate may exist, the examination of a number of adults and children unaffected with distortion, taken indiscriminately, has satisfied him that no obvious *natural* lateral curves, such as Bühring describes, are present in healthy persons."

My opinion entirely accords with that of Dr. Little, in doubting the existence of lateral curves as a normal condition of the spine, and I venture to offer my opinion in opposition to the high authorities above named, not only from examinations of the living, but from numerous and careful observations on the dead subject, a better test, inasmuch as in all lateral curvatures of the spine, the deviations of the bodies of the vertebræ are much greater than that of the spinous processes.

In the course of my experience in making post-mortem examinations during the twelve years—from 1842 to 1854—in which I filled the office of Demonstrator of morbid anatomy at St. Thomas's Hospital, I habitually examined the spine after eviscerating the bodies, and remarked the great rarity instead of the frequency of any lateral deviation. Working in this great field for so long a period, I obtained but few specimens of spinal curvature for dissection.

I have known this belief in the existence of a slight lateral curvature of the spine as a normal condition, lead to a very unsound opinion in practice; for instance—in July, 1856, a young lady was brought to me from France, with a slight spinal curvature, which had excited the anxieties of an aunt, whose sister had been under my care for a most severe form of lateral curvature. A French physician had previously been consulted, and endeavoured to quiet the alarm of the family by assuring them that "a little prominence of the right shoulder

always existed in young ladies, and was no more than an ordinary and natural condition, and that the spine, in fact, *ought not* to be quite straight." Fortunately this startling opinion had the effect of increasing the anxiety it was intended to allay. The case was slight, but had everything against it in the constitution and habits of the girl, and the utmost care was therefore necessary to prevent deformity.

At first I ordered a combination of lying down and gymnastic exercise, the treatment I always adopt when a case is brought to me at a sufficiently early period, but in the present instance was obliged to add mechanical support in consequence of a disposition to increase in the curvature. The case is now completely cured, and mechanical support discontinued. I would, therefore, caution you against admitting this opinion as to the existence of lateral curves as a normal condition of the spinal column, not merely in consequence of the serious errors in practice to which such a belief might lead, but because I consider it to be essentially unsound, and that it will be satisfactorily disproved by more extended and careful observations.

LECTURE II.

PHYSIOLOGY OF THE SPINE IN RELATION TO THE PRODUCTION OF LATERAL CURVATURE.

HAVING given in the last Lecture a general sketch of the anatomical construction of the spinal column, I will now briefly advert to a few points in the physiology of this complicated and important structure, with especial reference to the mechanism of motion, and the mode of production of spinal curvature. It is unnecessary for me here to make more than a passing observation on the important functions of the spinal column, as destined to enclose and protect the great nervous centre—the spinal cord; and also to give attachment to those important appendages of the spine, the ribs which, together with the sternum, enclose the cavity of the chest and protect the heart and lungs. In connection with spinal curvature, however, it is essentially necessary to bear in mind the important office of this osseous frame-work of the body formed by the spine, ribs, and sternum, as affording attachment not only to many of the muscles which regulate the movements of the trunk and the extremities, but also to some of the most important muscles of respiration,—a function perhaps more than any other interfered with in cases of severe spinal curvature, in consequence of the connection of the diaphragm and intercostal muscles with the spinal column and the ribs.

To proceed, then, with that portion of the physiology of the

spinal column most intimately connected with our present inquiry, I will make a few observations on

The Mechanism of Motion in the Spinal Column, and the essential difference between its Flexibility and the Free Motion allowed in the Movable Articulations of the Extremities.

In the mechanical construction of the spinal column, one of its most important features is that whilst it is admirably adapted to the erect position of man, a certain amount of flexibility is also provided for. Now in reference to the mode of production of spinal curvature, it is important to consider the precise manner in which flexibility of the spine is obtained; by what means it is limited and directed in adaptation to the requirements of the erect position of man; and to determine how far the movements of the spinal column are analogous to, or different from, the free motion allowed in the movable articulations of the extremities.

These inquiries are especially necessary because some writers who delight in tracing the analogy of lateral curvature of the spine, in its mode of production, to the ordinary muscular contractions and deformities of the limbs, would assume a similarity in structure and anatomical arrangement, between the articulations of the spinal column and the movable articulations of the extremities; at least, such an assumption is necessary to their theory of the production of spinal curvature, and by some it has been plainly expressed; but to me this appears an error which cannot be too forcibly pointed out.

M. Jules Guérin,* in advocating his theory of spinal curvature, which he holds to be essentially identical with club-foot, wry neck, and other deformities, which have been ascertained to depend upon active muscular contraction, traces the analogy in causation rather than mechanism; but he necessarily assumes that the mechanism and physiological construction would permit the operation of such causes in the production of the phenomena of spinal curvature,—an assumption which

* "Mémoire sur l'Étiologie Générale des Déviations Latérales de l'Épine, par Rétraction Musculaire Active." Par Dr. Jules Guérin. Paris, 1840.

I shall endeavour to prove to be totally opposed to the anatomical and physiological conditions of the spinal column.

Dr. Little argues strongly in favour of the analogy between lateral curvature of the spine and deformities of the limbs,—not only from advocating, like Guérin, the identity of causation, but also from the supposed similarity in structure and mechanism. In his Lecture on lateral curvature,* the heading commences with “Distortions of spinal column analogous to Contractions in other parts of the frame,” and on the same page he observes, “I have in the next place to treat of those distortions of the spinal column, which in their nature correspond with *contractures* in other parts of the frame. *Contractures* are those distortions which result from the operation of causes which *indirectly* affect the articulations. . . . In the general remarks at the beginning of the last Lecture, I laid down the proposition that, having in the spinal column, bones, ligaments, and muscles, similar to those in other parts of the frame, we should expect to meet in the spine with similar pathological states.”

The late Mr. Stafford also believed in the analogy of lateral curvature of the spine with the contractions and deformities of the movable articulations of the extremities, and observes, “The muscles and the ligaments on the concave side of the curve are necessarily contracted, and consequently are rendered incapable of performing their proper functions, whilst those on the convex side are equally stretched beyond their natural tension, by which they also are in a greater or less degree made useless. This state of the parts is precisely analogous to what occurs in the contraction of other joints; the flexor muscles are preternaturally contracted, and the extensors elongated.”†

My former colleague, Mr. Tamplin, even more precisely described the supposed analogy between the mechanism of

* “On the Nature and Treatment of the Deformities of the Human Frame,” page 358, by W. J. Little, M.D., London, 1853.

† “Two Essays on the Diseases of the Spine,” page 62, by R. A. Stafford. London, 1844.

motion in the spinal column and the free motion allowed in the movable articulations of the extremities. "The general cause of lateral curvature," observes Mr. Tamplin,* "is debility, unattended with disease. It is precisely analogous in its nature and cause to other deformities in other joints—viz., debility, or loss of tone; for example, that common deformity, knock-knees or inward inclination, of which so large a number are found in the report; the only difference is, that here we have but one joint instead of many." And again, at page 23, Mr. Tamplin observes: "The spinal column, as I have endeavoured to prove, differs in no respect, except in that of its position and the number of its articulations, from any other articulation;" and, at page 22, he also states, as a deduction from these postulates:—"The indications of treatment, therefore, are as simple in this as in any other distortion, or as in that of a common dislocation."

Now, a careful examination of the mechanism of motion in the spinal column has led me to form an opinion diametrically opposed to that expressed by the above-named authorities, and to differ as widely from the theories which they have propounded in explanation of the causes and mode of production of spinal curvature, as well as the principles upon which they consider the treatment of this affection should be conducted. Let us therefore examine this subject more closely, and first as to the—

Classification of Joints.

We know that anatomically all the articulations of the skeleton are arranged in three classes—viz., *the immovable*, such as the articulations of the bones of the skull; *the movable*, as in the knee, hip, elbow, and other joints of the extremities; and *the mixed*; and that the articulations between the bodies of the vertebræ, together with the articulation at the symphysis pubis, and also that between the first two bones of the

* "On Lateral Curvature of the Spine," page 21, by R. W. Tamplin. Churchill: 1852.

sternum, are always given as illustrations of the mixed form of articulations.

In the movable articulations of the extremities, the joints possess a free and extended range of motion, the articular surfaces moving freely on each other as polished surfaces, but restrained within certain limits by strong ligamentous bands, as in the knee, hip, elbow-joints, &c.

In the mixed form of articulations—intermediate between the immovable and the movable—the joint-surfaces are not directly in contact with each other, but connected by an intermediate substance, which will permit of some flexibility and yielding, *but not of surface-play*; as, for example, in the articulations between the bodies of the vertebræ, the sacro-iliac articulations, the articulation at the symphysis pubis, and also that between the two first bones of the sternum. In all these articulations a layer of fibro-cartilage is placed between, and intimately connected with, the contiguous surfaces of the bones.

No other than this mixed form of articulation, in which all free motion and surface-play is absent, would be adapted to the erect position of man. If free motion existed between the vertebræ, not only would all the advantages of the solid osseous framework of the trunk be lost, but the erect position and equilibrium of the body could be maintained only by the strongest muscular effort; whereas, I shall prove that in consequence of the absence of free motion and surface-play between the vertebræ, as well as the mechanical arrangement of the oblique articulating processes, by which the vertebræ are locked one within the other, and the arrangement of the resisting ligamentous structures, the erect position of man is maintained by the smallest possible expenditure of muscular force as far as the spinal muscles are concerned, and that the erect position is that in which the spinal muscles are least in action.

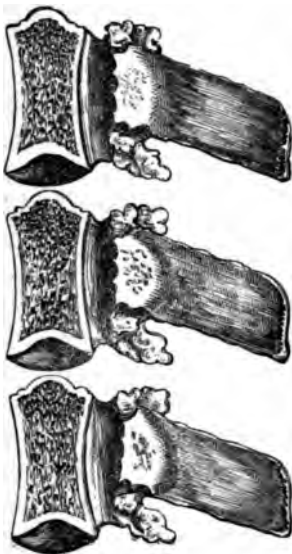
In some of the lower vertebrate animals, free motion and surface-play between the different vertebræ are especially provided for, and in their locomotion we see the great

advantages of such arrangement; let us for a moment glance at

The Comparative Anatomy of the Spinal Column in Relation to its Mechanism of Motion.

In the lower vertebrate animals we see the flexibility of the spinal column at its maximum, and locomotion is principally or entirely performed by the flexion of the body upon itself, as

FIG. 1.



Section of spine of reptile, showing ball-and-socket articulation between vertebrae.

in serpents, eels, &c. In reptiles, generally, the spinal column is characterised by the ball-and-socket articulation of the vertebrae, each vertebra having one surface convex and the other concave, as shown in Figure 1; both the articulating surfaces are covered by a thin layer of articular cartilage, so as to allow of free surface-play, but as Dr. Carpenter* observes, "In proportion as distinct members are developed, and the power of locomotion is committed to them, we find the firmness of the spinal column increasing, and its flexibility diminishing."

Mayo† in his admirable description of the mechanism of the joints, observes: "The joints of the bodies of the vertebrae deserve to be particularly described. In fish, in which the spine is very flexible, the articular surfaces of the bodies of the vertebrae are so excavated, that when two meet they inclose a cavity, the shape of which may be called spherical, as shown in Figures 2. This cavity is filled with fluid which we will suppose to be incompressible, whilst the margins of the two vertebrae are joined together, by the inter-

* "Principles of Human Physiology." London: Churchill, 1846. Page 9.

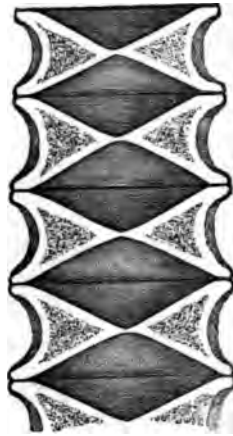
† "Outlines of Human Physiology." London: Churchill, 1837. Page 336.

vention of a ligamentous substance which is highly elastic; (Mayo considers that ligaments "are very flexible, but have very little extensibility.") "Thus, a double ball-and-socket joint exists between every two vertebræ, each of which is capable of rolling in every direction upon the ball of liquid contained between the two. In the human spine the same type is followed, but with a provision for much less latitude of motion; the excavation is shallow, the central substance semi-fluid, and the surrounding fibro-cartilage is confined by ligamentous bands of a less elastic substance."

I quote these observations from Professor Mayo, because they appear to me specially worthy of attention, though like many other valuable observations made by that excellent physiologist and pathologist, they have either failed to attract the attention they deserve, or have been inadequately acknowledged.

In the most recent anatomical works (see Quain and Sharpey, pages 5 and 187), the bodies of the vertebræ are described as "in most instances flat on the superior and inferior surfaces," and the intervertebral cartilage is described as a "plate or disc of fibro-cartilage placed between the bodies of each pair of vertebræ" Yet in every drawing representing the vertebræ in section (see Quain and Sharpey,† from which the annexed wood-cut is copied,) we see the concavity, or excavation, of the adjacent surfaces of the bodies of the vertebræ, and the elliptical form of the section of the inclosed intervertebral cartilage carefully figured by the artist. Modern anatomists appear to have overlooked the effect which the

FIG. 2



Section of spine of fish, showing concave surfaces of bodies of vertebræ, and diamond-shaped space for gelatinous fluid between the bones—Double ball-and-socket type of articulation.*

* From a dried specimen. In the recent state the bones are sufficiently separated to allow of motion between them, and considerable flexibility.

† Fig. 117, page 134. Vol. I., Eighth Edition, 1876.

annular epiphyses, surmounting the margins of the bodies of the vertebræ, have in deepening the articular surfaces of the bodies of the vertebræ and to some extent assimilating them in form to the concave surfaces of the bodies of the vertebræ in fishes.

FIG. 3.



Section of human spine showing concave surfaces of bodies of vertebræ, and elliptical form of inclosed intervertebral substance, approaching to the double ball-and-socket type of articulation.

Absence of any Analogy between the Articulations of the Human Spine, and the Movable Articulations of the Extremities.

Having pointed out, in the preceding observations, the anatomical dissimilarity between the articulations of the bodies of the vertebræ in the human spine, and the movable articulations of the extremities, I have also shown that those who would endeavour to prove the analogy between spinal curvature and deformities of the limbs, have entirely overlooked the fact that the existence of the intervertebral cartilage, destroys all anatomical analogy between the articulations of the spine and the movable articulations of the extremities. In endeavouring to trace such an analogy, joints with the minimum of motion, as in the spinal column, are compared with joints possessing the maximum of motion, as in the movable articulations of the extremities, without the anatomical peculiarities which regulate the minimum and maximum of motion being taken into consideration, and merely because both sets of joints are liable in their flexions to produce deformities. The causes

of deformity in both have also been assumed to be identical, because their motions are to a greater or less extent regulated by the muscles.

In these remarks I exclude the articulations between the occipital bone and the atlas, and between the atlas and dentata; I need hardly remind you that between the occipital bone and the atlas we have a ball-and-socket articulation, and also that between the atlas and the dentata we have a joint admitting of horizontal rotation, so that the head may possess the greatest range of motion in every direction.

If, then, there is no anatomical analogy, as far as the mechanism of motion is concerned, between the spine and the movable articulations of the extremities, why should we endeavour, for the sake of any general theory, to trace out analogies between curvatures of the spine and deformities which occur at the movable articulations of the extremities? rather let us study the distortions of the spine by the light of the special anatomical peculiarities which belong to this complicated structure.

Some authors—and amongst them especially Dr. Little*—endeavour to support their arguments, in favour of the supposed analogy between the deformities of the spine and of the limbs, by reference to the well established analogy in the liability to *disease* between the spine and the joints of the extremities; but this does not appear to me to assist the argument. We know full well the liability which exists in the spine to necrosis and caries of bone, ulceration (if it may be so called) of cartilage; to rheumatic inflammation of the ligamentous and other fibrous structures in the neighbourhood, &c.; and that to these affections the movable articulations, including the joint-ends of the bones are especially predisposed. Whilst I would fully concur in tracing this analogy in the liability to disease, and have myself advocated it more strongly than other authors have done, I would as strongly insist upon the difference between the *deformities* of the spine and of the limbs in consequence of a dissimilarity in the anatomical arrangement of the

* *Op. cit.*, page 340.

structures, and the mechanism of the joints in reference to the production of motion.

In the human spine we may, as Mayo observes, trace the double ball-and-socket type of articulation in the joints between the bodies of the vertebræ below the second cervical, or *dentata*. We know that this form of articulation is calculated to give the greatest range of motion; and where so many of these joints exist, as in the length of the vertebral column in the human subject, the flexibility of the human spine would approximate to that of the spine of fishes, and would be as uniform in the different regions; but as any such mobility would be ill adapted to the erect position of man, we have both the lateral and the antero-posterior motions checked by the oblique articulating processes. Let us, then, reflect upon

The Situation, Form, and Functions of the Oblique Articulating Processes of the Spine.

For the purpose of maintaining the direct connection between the contiguous vertebræ, there are four oblique articular processes connected with each vertebra—two superior and two inferior—which, except in the two first vertebræ, project one on each side, from the junction of the lamina with the pedicle. The articular surfaces of these oblique articulating processes unlike the articular surfaces of the bodies of the vertebræ, are coated with a thin layer of articular cartilage, as in the movable joints of the extremities. They are directed in pairs backwards and forwards with varying inclination upwards, outwards, and inwards, in the cervical, dorsal, and lumbar regions; the directions of the superior oblique articulating processes in the 5th cervical, the 9th dorsal, and the 2nd lumbar vertebræ, are shown in Plate I, figs. 2, 3, 4. These surfaces are flat and smooth, and are held in close apposition by short and strong ligamentous bands attached to their margins, clearly indicating the slender provision for free motion or surface-play between the articular surfaces.

In considering the mechanism of motion of the spinal column, it is important to observe that these oblique articulating processes

are situated posterior to the vertebral canal, and therefore very far behind the bodies of the vertebræ. There can be no doubt that the special function of these articulating processes, beyond that of affording a direct connection between contiguous vertebræ is, not to increase, but on the contrary, to limit and direct the movements—it would be more correct perhaps to say the flexibility—of the vertebral column in the different regions. This is contrary to the functions of the other movable articulations of the skeleton, which are all special provisions for increased motion, but the necessity for this limitation in the vertebral column has been shown by the double ball-and-socket type of the articulation between the bodies of the vertebræ, and the necessary adaptation of the spinal column to the erect position of man.

Horizontal Rotation-Movement of the Spinal Column limited by the Oblique Articulating Processes.—In many attitudes of the body there is an appearance as if a movement of horizontal rotation, or spiral twisting, were freely permitted in the spinal column; but, on a careful examination, it will be seen that this appearance almost entirely depends upon the horizontal rotation of the head above, and the twisting of the pelvis upon the hip-joints below, by which the base of the spinal column is rotated. The extremely limited extent of this movement in the spinal column may be tested by fixing the pelvis firmly in the sitting position, and then trying to twist the body, of course avoiding a false appearance of this motion by exaggerated movement of the shoulders and arms.

In the articulations of the bodies of the vertebræ generally, the firm connection between the surfaces of the bones and the intervertebral cartilages would, of course, prevent any surface-play, either in the direction of horizontal rotation or any other direction; but it is important to observe that, whilst in the mechanism of motion for the head there is a special provision for the movement of horizontal rotation by free surface-play in the movable articulation between the atlas and dentata, we find the form and arrangement of the oblique articulating processes adapted to limit the movement of horizontal rotation in the

spinal column generally. Mr. Bishop observes,* "The dentata cannot revolve on the succeeding vertebra, in consequence of the oblique articulating surfaces of the latter lying in one and the same plane. In the dorsal vertebræ the oblique surfaces do not lie in the same plane, but are directed so as to form portions of a conical surface about the axis of the body, whereby they are allowed a certain amount of twisting action. In the lumbar vertebræ the oblique processes are large, and their surfaces are excavated, and almost perpendicular to the upper surface of the body, so as to prevent any twisting, or spiral motion whatever, of the trunk about the axis. We have seen why the vertebræ cannot revolve about the axis of their bodies except in a limited degree."

When, therefore, horizontal rotation of the bodies of the vertebræ occurs as a morbid condition, as it invariably does in the so-called *lateral curvature* of the spine, and as one of the earliest and most important pathological conditions, it must necessarily be accompanied with some alteration in form of the articulating processes.

In the professional gymnast this rotation movement is so materially increased by the system of training in childhood, that its existence can easily be demonstrated. This I have had the opportunity of proving by personal examination, through the courtesy of Mr. Mahomed, of Brighton, who has ingeniously contrived special gymnastic exercises to correct the rotation-movement existing as a morbid condition in lateral curvature.

Lateral Flexion of the Spinal Column limited by the Oblique Articulating Processes.—If, as I have just stated, the horizontal rotation-movement, or twisting of the spinal column, is more apparent than real, and that this movement is really very limited, whilst in some of the varied attitudes assumed by the body there is an appearance as if it were freely permitted, I would observe that the same may be stated with respect to the flexibility of the spinal column in a lateral direction, more especially in the lumbar and dorsal regions.

We imagine the lateral flexibility of the spine to be much

* *Op. cit.*, page 28.

greater than it really is, but a more careful examination of the mechanism of motion of the spinal column will convince us that even in the lateral-flexion attitudes assumed by the gymnastic exhibitors, the appearance of lateral flexibility of the spinal column is chiefly dependent upon:—

1st. The obliquity given to the spinal column by tilting of the pelvis, thus altering its base of support from the horizontal to an oblique direction—a movement permitted by the ball-and-socket form of articulation of the hip joint: and,

2nd. Upon the free mobility of the head in all directions, which is permitted by the movable ball-and-socket form of articulation between the occipital bone and the atlas.

In order to test this limited lateral flexibility of the spinal column, examine a man while standing naked before you, and direct him to bend his body sideways whilst you place your hands on the pelvis, resting on the crest of the ilium on each side. You will then find that he immediately drops his head to one side and shifts his pelvis, but if you check the least movement of the pelvis, and do not allow the head to be inclined beyond a line corresponding to the direction of the spinal column, and at the same time prevent any undue muscular movement of the scapulæ, you will find the flexibility of the spine in a lateral direction to be extremely limited.

This will then convince you that the graceful lateral postures which you may have often admired either in female dancers or gymnastic exhibitors, and which have been attributed to the flexibility of the spinal column, are mainly due to the ball-and-socket articulations of the hip joints and of the head. Although we admit that in these professionals the range of motion in the spinal articulations is materially increased by their training in childhood.

The explanation of the limited flexibility of the spinal column in the lateral direction, will be found in the form and direction of the oblique articulating processes already described.

In the lumbar region, the oblique articulating processes are so arranged as to prevent any lateral movement, or to reduce it to its minimum degree as shown in Fig. 4. In direction they

are nearly perpendicular, and their large articulating surfaces look almost directly inwards and outwards, so that being closely applied to each other and held in contact by short ligamentous bands, all lateral movement appears to be effectually prevented,

FIG. 4.



Lumbar vertebra of human subject, showing oblique articulating processes, and perpendicular direction of articular facets.

motion in the antero-posterior direction only being allowed; but as the intervertebral cartilages are in this region very thick and compressible, the flexibility in the antero-posterior direction is considerable. Hence it is clear that when lateral curvature occurs in the lumbar region, which it does at least as frequently as in the dorsal, it is not simply an exaggeration of a natural movement in this direction, as every anatomical provision is made to prevent lateral mobility.

Mr. A. Shaw observes: "If we attend to the natural structure of the spine, it will be seen that whilst we lean the body to one side, the pressure is thrown almost exclusively upon the articulating processes of that side; these processes, delicate as they are, being the only bony structures which check the lateral movements of the trunk."*

These considerations are of more importance than might appear at first sight in connection with the purely muscular theory of the production of lateral curvature of the spine, and the direct lateral movement of the spine supposed to characterise that affection.

In the dorsal region the oblique articulating processes are also

* *Medico-Chirurgical Transactions*, vol. xvii., p. 468.

arranged so as to allow only an extremely limited amount of flexibility in the lateral direction ; but in the cervical region this movement is more freely permitted.

Flexion of the spinal column in the antero-posterior direction is much more freely permitted than lateral flexion, but an attentive observation of this movement of the spine, when carried to an extreme degree, as by gymnastic exhibitors, &c., will convince you that the appearance of great mobility of the spine, either in the anterior or posterior direction, is chiefly due to the free ball-and-socket articulations of the hips and of the head, and that next to these articulations the largest share in the movement is taken by the flexibility of the cervical or lumbar vertebræ according to circumstances.

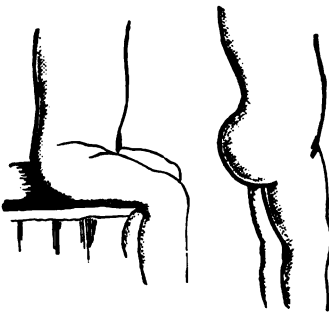
As a familiar illustration, look at a boy in the game of leap-frog, when he is "*making a back*," as it is called in play-ground phraseology, and observe how much depends upon the head and neck being bent downwards and inwards,—the play-ground expression for which will probably occur to you. In this attitude you will also observe that the whole length of the spine is inclined forwards by the tilting of the pelvis upon the hip-joints, a movement which is increased in proportion as "*the back*" is lowered ; but in this position, or in the more exaggerated one of making the fingers touch the toes whilst the legs are kept perfectly straight, or extended, a certain amount of flexion or bending forwards, takes place both in the dorsal and lumbar regions of the spine ; the anterior curvature in the lumbar region, so conspicuous in the erect position, is not only obliterated, but to some extent reversed, and a posterior projection produced in the loins, whilst the natural posterior curvature in the dorsal region is increased. To produce these alterations in the form of the spine, there can be no doubt that the intervertebral cartilages are much compressed anteriorly, and that a certain amount of motion takes place at the joints of the oblique articular processes.

An examination of these joints in the lumbar region will convince you that, from the direction of their articular surfaces, a considerable range of motion is permitted in the antero-posterior

direction, though it will be evident that very little motion at each of these articulations is required in consequence of their being placed so far behind the bodies of the vertebræ, and also in consequence of the compressibility of the intervertebral cartilages.

Further to illustrate the flexibility of the spine, in the loins, in the antero-posterior direction, observe the difference in the

FIG. 5.



Variation in lumbar curve in sitting and standing positions.

form of the spine in the sitting and standing positions. In the sitting position the hollow of the loins entirely disappears, in consequence of the pelvis assuming a straight instead of an oblique position, as shown in the two figures represented in Fig. 5. In the sitting position there can be no doubt that the intervertebral cartilages between the lumbar vertebræ, and more especially that between the last lumbar vertebra and the

sacrum, must be compressed anteriorly to a very considerable extent. The alteration in the form of the spine in these positions is very remarkable in cases in which the natural anterior curvature in the lumbar region is exaggerated, in the erect position, by tilting of the pelvis forwards, as we see it in cases of ankylosis of the hip-joint, with flexion of the thigh, after hip-joint disease; or even to a greater extent in cases of congenital dislocation of both hips.* In some of these cases the tilting forwards of the pelvis is so great in the erect position that the sacrum is nearly horizontal, but nevertheless is made to assume almost a vertical direction in the sitting

* Casts taken from cases of this rare affection may be seen in the museum of the Orthopædic Hospital. A complete statue of a well-marked case in a boy is in the museum of St. Thomas' Hospital. The boy was brought to the hospital by Dr. Carnochan of New York, in the year 1845, and Fig. 9 is copied from a representation of this boy in Dr. Carnochan's book.

position, and thereby the exaggerated lumbar curve at once disappears, and the spine becomes straight in this region ; or it may be even slightly bowed outwards.

This flexibility in the antero-posterior direction, in the lumbar region, constitutes the greatest difficulty in removing, by gradual mechanical extension, the deformity of the hip-joint which usually remains after hip-joint disease—viz : flexion of the thigh, often at a right angle, associated with ligamentous ankylosis of the hip-joint. The leg may appear to be straightened when examined in the apparatus, and the surgeon congratulates himself upon the result, but when the instrument is removed, it will be found that the effect has been produced by increasing the tilting of the pelvis anteriorly, instead of straightening the thigh, so that no real improvement has taken place.

I will now briefly review the different statements which have been made by physiologists and by authorities on spinal curvature in reference to the

Flexibility in different regions of the spinal column.—Much difference of opinion exists as to the relative degrees of flexibility in the different regions of the spine. With regard to the source of this flexibility, Mr. Bishop correctly observes : “As the bodies of the vertebræ are inflexible, the flexibility of the vertebral column is derived entirely from the compressibility and elasticity of the intervertebral cartilages, and a knowledge of their dimensions—namely, their length, breadth, and thickness—is necessary in order to enable us to estimate the relative flexibility of the cervical, lumbar, and dorsal regions.”* Speaking of the relative proportion of the intervertebral cartilage in the different regions of the spine, Quain and Sharpey† state that “the dorsal division of the spine has, comparatively with the length, a much smaller proportion, and has accordingly less provision for pliancy than the cervical or lumbar portions of the column.” Mr. Skey‡ observes that “nature has given to

* *Op. cit.*, page 34.

† See Quain and Sharpey’s “Anatomy,” vol. i. page 189.

‡ “On Lateral Curvature of the Spine,” page 6. Second Edition, London, Churchill, 1842.

the region of the loins the greater freedom of motion, because that portion of the body is midway between the head and the feet." Upon this observation Mr. Bishop* remarks, "Mr. Skey appears to have entirely mistaken the relative degree of flexion of which the spine is susceptible. . . . Now, not only has the lumbar region the least power of motion in the whole column, but a greater mobility would have tended to render the movements of the superincumbent part unstable, and a person in such a predicament would be what is vulgarly termed *top-heavy*," and from Weber's very exact measurements of the length, breadth, and thickness of the intervertebral cartilages in the different regions of the spine, Mr. Bishop states, "that under an equal force, the dorsal and lumbar portions of the spine possess very nearly equal degrees of flexibility, and that the cervical portion has nearly three times the flexibility of either the dorsal or the lumbar."†

As some explanation of the diversity of opinion on this subject, I would observe that the very marked difference in the relative amount of flexibility in the lateral, and in the antero-posterior directions, in the several regions of the spine as limited and directed by the oblique articulating processes, has not been sufficiently noticed. To me it appears that the flexibility in all directions is greatest in the cervical, and most limited in the dorsal region; but in the antero-posterior direction, the flexibility is greatest in the lumbar region. No provision whatever exists for lateral motion in the lumbar region; a very important fact when we remember that lateral curvature as a morbid condition frequently commences in this situation. It is certain, therefore, that lateral curvature of the spine in the lumbar region cannot be regarded simply as an exaggeration of any natural movement in this direction, nor can it exist merely as a functional affection; when existing, even to a slight degree, it must necessarily be the result of a series of adapted structural changes.

* *Op. cit.*, page 36.

† *Op. cit.*, page 25.

Ligaments and Muscles of the Spinal Column; their Influence in maintaining the erect Position of the Spine, and in Limiting and Directing its Movements.

Ligaments of the Spine.—More than a passing observation on the ligaments of the spine would be unnecessary, were it not for the circumstance that most authorities on spinal curvature, appear to assume the existence of ligaments of which anatomically we have no knowledge, and to attribute to them an influence in the production of lateral curvature of the spine which is wholly imaginary. We are told, for example, by Tamplin, that in lateral curvature of the spine, “the ligaments are elongated on the convex side, and contracted on the concave side, offering the most obstinate resistance.” What ligaments can possibly be alluded to? I am not aware that any distinct lateral ligaments exist along the bodies of the vertebræ. In this situation there are only some short and irregular ligamentous bands interlacing and crossing over the intervertebral cartilages. We are all familiar with the strong anterior and posterior ligaments which, attached to the bodies of the vertebræ and the intervertebral cartilages, traverse the length of the spinal column—the atlas and dentata excepted; but we have no lateral ligaments such as exist in the movable articulations of the extremities. We can hardly imagine that the short and dense ligaments connecting the oblique articulating processes are alluded to, since the form and direction of the articular surfaces would render such a change impossible; moreover, I shall hereafter prove to you from dissections, that in all cases of spinal curvature, however slight, these articular surfaces themselves become altered in direction and form, and that such alterations increase in proportion to the severity of the case.

The error of this *ligamentous theory* of the production of lateral curvature has been forcibly pointed out by Mr. Skey, who observes,—“Among the immediate or proximate causes of unequal pressure on the spinal column has been assigned, by some medical authorities, an unhealthy relaxation of the ligaments of the spine, but with no rational explanation; indeed,

it is difficult, anatomically speaking, to explain this view on any satisfactory grounds; because, in truth, there are no lateral ligaments of the spine the relaxation of which would throw any light on the disease.* It appears to me that the assumption alluded to with respect to the existence and conditions of certain imaginary lateral ligaments of the spine,—an assumption to be found in most of the works on lateral curvature,—is only a part of the more general theory, I might call it the *muscular and ligamentous theory*, of the production of spinal curvature, which assumes a close analogy, and sometimes an identity, between lateral curvature of the spine and the more simple deformities, affecting the movable articulations of the extremities, such as knock-knee, &c.

Having disposed of this error, then, I would especially remind you that, in the spinal column, as in other parts of the skeleton, the ligaments are placed where they are most required to limit the movements in certain directions. Lateral flexion of the spine in the dorsal and lumbar regions is limited chiefly by the form and direction of the oblique articulating processes, which are made still more firmly to lock the bones together by very strong and short ligamentous bands connecting the margins of the articular facets. As flexion of the spine, however, is more freely permitted in the antero-posterior direction, as in stooping forward or bending backwards, so you at once see why we have placed along the anterior and posterior surfaces of the bodies of the vertebræ the strong ligaments described as the *anterior and posterior common ligaments of the spine*; and also why, posteriorly, the arches of the vertebræ and the spinous processes are connected by very strong ligaments. All these ligamentous structures serve not only to limit the movements of the spine in certain directions, in which motion is less restrained by the form of the bones, but also to economize muscular force in maintaining the equilibrium of the body in any position we may assume.

Muscles of the Spinal Column.—It appears to be generally

* "On Lateral Curvature of the Spine," page 16. Second Edition. Churchill, 1842.

considered by authors on spinal curvature that the erect position of the spinal column is maintained principally by its muscles and ligaments, especially the muscles, no importance being attached to the form and mechanical construction of the articulations of the spinal column, in virtue of which it is admirably adapted to maintain the erect position with the smallest expenditure of muscular force. The vertebral column appears to be regarded by those authors as if it consisted of a number of bones placed one above the other, and connected together by free movable articulations, such as the knee-joint, and other joints of the extremities; and they seem to consider that it is only by the nicest balance of active muscular force that the erect position can be maintained.

We have seen that the stability of the spinal column is insured in consequence of its pyramidal form, the connection between the bodies of the vertebræ by the intervertebral cartilages, and the way in which the vertebræ are locked one within the other, by the oblique articulating processes, and retained in direct connection by ligaments; and there can be no doubt that in consequence of the anatomical arrangement of this complicated structure, the spinal column, is admirably adapted, *per se*, to the maintenance of the erect position of the body with the least possible expenditure of muscular force.

If you remove the spine from the body, and dissect off all the muscles, leaving the bones connected only by the ligaments, you will find that it is still a firm column, not only preserving its erect form with all its natural curves, but that its flexibility in any direction is very limited. How different is this from the knee or hip-joints similarly dissected. I fully concur in the opinion expressed by Mr. Bishop—to whose laborious investigations of the mechanism of motion and the physiology of the spinal column I have repeatedly adverted—that “in the erect position of the body the ligaments of the spine are in the state of least action, as are also the muscles, because in that position no stretching force is exerted, either on the oblique articulating processes, or on the bodies of the vertebræ, and therefore the ligaments must be in a state of

repose;”* and again, at page 48, he observes “it will be shown in a subsequent chapter that the erect position of the body is that in which there is the least expenditure of muscular action; it therefore follows that some of the muscles must act at a mechanical disadvantage whenever placed out of this attitude; but, as any constrained attitude is irksome if much prolonged, a transfer of action from one set of muscles to another, is attended with a sensation of ease.” The relief afforded by varying the positions of the body, as familiarly illustrated by the military order “Stand at ease!” &c., are then alluded to by Mr. Bishop.

The great object in the mechanical and physiological construction of the human skeleton, of maintaining the erect position of the body with the least expenditure of muscular force, is largely effected by the anatomical mechanism of the spinal column, and is further assisted by the way in which the head—which it is the special object of the spinal column to support—is connected with the spine. In Quain and Sharpey’s “Anatomy,”† the observation is quoted from Lawrence‡ that “The condyles, or points of articulation of the head, are situated very near the centre of its base, being, however, a little nearer to the occipital protuberance, than to the anterior surface of the jaws; by this arrangement very little active power is required to maintain it *in equilibrio*.” Hence no necessity exists in the human subject for the *ligamentum nuchæ* placed in the lower animals to economize muscular force in maintaining the position of the pendent head. The general principle of economizing muscular force in the erect position of the body, is to be traced not only in the spinal column, where it is most conspicuous, and where the muscular force required is reduced to its minimum, but also in the mechanism of the movable articulations of the extremities, as in the knee and hip-joints. In the spinal column this is clearly evidenced by the large size and form of the articular surfaces of the bodies of the vertebræ; but in the knee and hip-joints a

* *Op. cit.*, page 37.

† *Op. cit.*, page 97.

‡ “On the Characters of the Human Head.”

much larger expenditure of muscular force is necessary to maintain the erect position of the body, and, indeed, in these articulations, the maximum of muscular force, in comparison with the other articulations of the body is required. To compare these articulations, then, physiologically and pathologically in explaining the causes and mode of production of lateral curvature of the spine, as most writers on spinal curvature have done, appears to me to be an error requiring but little reflection to correct.

The difference in the relative amount of muscular force required to hold the spine erect, and to maintain the erect position of the body at the movable articulations of the extremities, we frequently see illustrated in the inability of patients recovering from fevers, &c., to stand, long after they have been able to sit up in bed. I remember a patient recovering from a severe attack of scarlet fever, who had sat up in bed for several days, and feeling himself so much stronger said, "Now I am sure I could walk across the room," and though advised not to do it, he proceeded to make the attempt, and instantly fell to the ground; the muscles of the lower extremities being too weak to maintain the movable joints of the knees and hips in the erect position.

The muscles of the spine are in a state of the least action when the spinal column is in the erect position. Instead therefore of the muscles of the spine in this position being in a state of *active tension* as assumed by some writers, it would be more correct to describe them as in a state of *vigilant repose*, ready on the instant to check and limit the flexion of the spine when its balance is disturbed, and thus to assist in preserving the general equilibrium of the body in any of the various attitudes which may be assumed.

As soon, however, as the equilibrium of the spinal column is disturbed, and the body inclined to one side, the spinal muscles on the convexity of the curve are called into increased action, and put violently on the stretch, becoming tense and prominent, while the muscles in the concavity of the curve remain soft and flaccid. The latter circumstance is practically

well worthy of remark, and appears to me to prove that *the spine is not drawn* into a curved position by the active contraction of muscles in the same way that the arm or the leg is flexed when the biceps and hamstring muscles respectively become prominent and tense, but that it bends passively as a flexible column, in consequence of disturbance of its equilibrium, the result either of some alteration in the angle of its base of support—some tilting of the pelvis—or of some alteration in the distribution of the weight it has to support above; a bending of the head, or the uplifting of one arm, &c.

I wish now, especially, to draw attention to the fact that when the body is inclined to one side in any gymnastic movement, the spine is bent laterally as far as this motion is permitted, the muscles in the concavity of the spinal curvature are flaccid and relaxed, while those on the convexity are tense and prominent; in lateral curvature of the spine, when established as a morbid condition, the same appearance presents itself, and in the explanations of this affection given by various authorities, such as—active muscular contraction—a spasmodic condition of the muscles—excessive use of the muscles of one arm and of one side of the spine—hypertrophy of muscles, &c.—the tension and prominence of the muscles on the convexity of the curve appear to have been frequently mistaken for the cause, instead of being recognised as the effect of the curvature. There can be no doubt that the muscles on the convexity of the curvature do exert their utmost power to restore the equilibrium, and, failing in this, to prevent further increase of the curvature; but I have not been able to satisfy myself that lateral flexion of the spinal column either as a healthy condition, or as a morbid affection, is ever produced by active muscular contraction.

Some exception to this general statement may perhaps be taken in respect of the lateral curvature of the spine consequent upon wry-neck, which we know in many cases is produced by active or spastic contraction of the sterno-mastoid muscle; but the exception is rather apparent than real, the spinal curvature being a secondary and late effect of wry-neck, and depending

at least as much upon the mechanical conditions as upon the physiological causes of this affection. When we see spinal curvature coexisting with wry-neck, there is generally no evidence of active spastic contraction of the sterno-mastoid muscle which is about an inch or an inch and a half shorter than the opposite muscle, and may be made tense and prominent in certain movements of the head, but is not constantly in a state of tension like the muscles of the leg or arm, in deformities we characterise as spasmodic.

Again, in the class of cases occasionally met with, in which we see permanent spinal curvature resulting from the long continuance of hysterical contraction of the scapular muscles, by which one scapula is drawn up two or three inches higher than its fellow, the same reasoning as to the mode of production of the spinal curvature will apply. I had an opportunity of witnessing a remarkable example of this kind in a girl, who remained a long time under the care of my late colleague, Mr. Lonsdale; a drawing from the cast of this case in the Orthopædic Hospital is represented in the annexed wood-cut.

The right scapula was habitually drawn up, at least in the day time, so that its inferior angle was three inches above the level of the inferior angle of the opposite bone as indicated by the dotted lines *aa*. Under the influence of chloroform, which was repeatedly administered to this patient, the contracted scapular muscles completely relaxed and the scapula

FIG. 6.



Lateral curvature consequent upon hysterical contraction of muscles of right scapula, which is drawn up three inches above its fellow.

assumed its normal position ; the spinal curvature also appeared to be removed, but as no benefit resulted from the constitutional treatment adopted during several months, Mr. Lonsdale applied a spinal support to prevent the consecutive lateral curvature becoming confirmed. In the course of time this patient discontinued her attendance at the hospital, so that the ultimate result of the case cannot be stated.

In such cases if the trapezius, levator anguli scapulæ, and rhomboid muscles of the right shoulder be affected, as they were in the case I have described, and the prominence formed by their contraction may be seen in the drawing, the spine will not be drawn into a curve on this side ; the contracted muscles remain in the concavity, but the convexity of the curve will be on the right side, and a second compensating curve will be formed to the opposite side in the lower dorsal and lumbar region as shown in Fig. 6.

It is certainly true that in some morbid conditions under which spinal irritation is produced, as in tetanus and in poisoning by strychnine, the spinal column is curved backwards and drawn into an arch, the concavity of which is directed backwards by the violent contraction of the posterior spinal muscles ; again in the powerful and prolonged muscular efforts made by the gymnast, especially those in which a weight has to be raised while the body is in a bent position and then balanced while the spine is curved backwards, or in which the spine is curved backwards and the body inclined so that the head is made to approach the heels, there can be no doubt that *the spine is drawn* into a curved position by the active contraction of the spinal muscles ; but in the ordinary positions of the body, and even in the attitudes generally assumed by dancers and gymnasts, I believe that the spinal column bends, not by any muscular contraction, or muscular force, but simply by disturbance of its equilibrium, in consequence either of some alteration in the inclination of its movable base taking place from the hip-joints, or from some inclination of the head and consequent alteration in the distribution of the weight it has to support.

It appears then, to be sufficiently proved that the spinal muscles are in the state of least activity in the erect position of the spinal column, and are called actively into play only when its equilibrium is disturbed, and that under ordinary circumstances, only those muscles on the convexity of the curve are called into play; hence, it would appear that the functions of the spinal muscles are not to produce by active contraction any flexion or curvature of the spine, but essentially to regulate and limit its movements, and to restore its equilibrium when disturbed. This power of muscular resistance enables the gymnast to preserve the general equilibrium of the body, and balance the trunk between the movable articulations above and below it, in any fantastic attitude he may assume.

LECTURE III.

ANTERIOR AND POSTERIOR CURVATURES OF THE SPINE.

A REVIEW of the anatomical and physiological peculiarities of the spinal column, would lead us to expect that this complicated structure, adapted to so many different functions, would become liable both to disease and distortion. *Diseases* affect its various structures—bones, cartilages, and ligaments—and are analogous to diseases affecting similar structures in other parts of the body. Of these diseases, ulceration of cartilage, necrosis and caries of bone, (resulting in posterior or *angular curvature*, known also as Pott's disease), and rheumatic inflammation of the ligaments, are the most common. *Distortions* or *curvatures* of the spine depend either upon the failure of some of the internal conditions necessary to its preservation in a healthy form,—I allude to its proper and healthy nutrition— or upon some external physical influences to which it must be pre-eminently exposed. Hence we have the constitutional and local origin of distortions.

These two classes of cases, viz., *diseases* and *distortions*, or deformities of the spine, were by the older surgical authorities frequently considered as one and the same form of lesion, but the wide separation between them, and their easy diagnosis—except, perhaps, in one form, viz., rotation of the lumbar vertebræ accompanied with severe pain—are too well known to render any observations necessary. I would, however, remark that in modern times, the distinction between these two classes of cases, viz, diseases and

distortions of the spine, has been drawn rather too broadly, inasmuch as it has long been customary for surgical authorities to describe the distortions or deformities of the spine, as merely functional affections, arising from muscular debility, &c., and unaccompanied with structural changes except in severe cases of long standing; whereas I shall endeavour to prove that it is anatomically impossible for any distortion of the spine, such as lateral curvature, however slight, to exist without being accompanied with structural alterations proportionate to the extent and duration of the curvature.

The spinal column, then, is liable to *distortion*, *i.e.*, fixed deviation from the erect position, so as to produce external deformity. Distortion may take place in the *antero-posterior* direction, either as an exaggeration of the natural curves of the spine which become so much increased as to produce external deformity; or the natural curvatures of the spine in the antero-posterior direction may be reversed, especially in the dorsal and cervical regions, *i.e.*, the dorsal curve may become depressed so as to project anteriorly, curving forwards instead of backwards; the cervical curve may project backwards instead of forwards; and the lumbar curve frequently becomes straight instead of curving anteriorly. Or distortion may occur as a lateral deviation, though the deformity described as *lateral curvature of the spine* does not depend upon a true lateral deviation, but rather upon a peculiar twisted, or contorted, condition of the spinal column, in which an external lateral deviation of the spinous processes generally, but not invariably, forms a conspicuous feature.

Deviations of the spine either in the antero-posterior, or the lateral directions, may coexist with destructive disease, affecting the intervertebral cartilages and the bones, more especially in the early stage; or they may be consecutive to such diseases, and remain as permanent distortions after the destructive process has been completely arrested. For example, when destructive disease occurs in the dorsal region, as we frequently see it in children, and sometimes in adults, the posterior convexity of the spine is very much increased, and

there may be great difficulty in deciding upon the existence or non-existence of disease. At a later stage, however, a sharp, angular projection of one or more spinous processes takes place, and all doubt as to the existence of disease is removed; but occasionally it happens that several intervertebral cartilages are affected without caries of the bones, as exhibited in preparations in St. Thomas' museum, No. E 20 and E 22, and in such cases no angular projection of the spinous processes would take place.

When destructive disease in the lower dorsal and upper lumbar vertebræ has become arrested, with the ordinary result of angular projection backwards of three or four spinous processes, the spine becomes altered in form, as a consecutive condition, in the middle dorsal region where it is either depressed so as to form a straight line when viewed in profile, or the natural direction of its curve may be reversed, and a concavity instead of a convexity may exist.

When destructive disease attacks the middle and lower lumbar vertebræ, it occasionally happens that the natural concavity in this region is considerably increased in the early stage of the affection. I saw a remarkable instance of this kind in a young woman, who was admitted into the Orthopædic hospital under my late friend and colleague, Mr. Lonsdale. The increase of the lumbar curve and hollowness of the loins was almost as considerable as we see it in cases of ankylosis of the hip-joint at right angles after disease, or in cases of congenital dislocation of both hips; the spinal muscles on either side were very prominent and tense, and a deep depression in the median line existed between them. The nature of the case was obscure; destructive disease was not suspected, the usual symptoms being absent; it was regarded as essentially a spasmodic or spastic muscular affection, and the propriety of dividing the muscles was discussed. Mr. Lonsdale however applied a spinal instrument with crutches and a webbing band in front. In the course of a few months the increased lumbar curvature disappeared, and afterwards a posterior, or rather angular, projection of the spinous processes of the twelfth dorsal

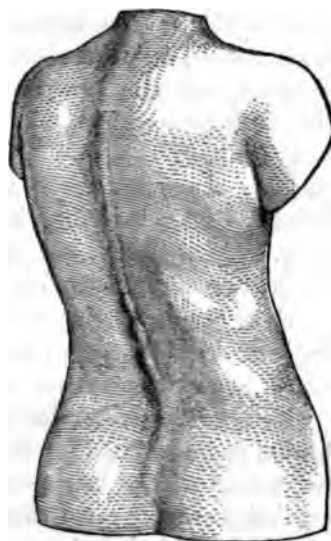
and the first and second lumbar vertebræ appeared. The disease ran a remarkably favourable course, the more severe symptoms usually met with when disease exists in this region never appearing, and the girl remained in service; she continued to wear a spinal support, and for two or three years came occasionally to the hospital. Casts from this case, from which Figs. 7 and 8 were taken, are preserved in the museum of the hospital.

FIG. 7.



Showing lordosis in lumbar region with contraction of spinal muscles, in a case of incipient caries of spine.*

FIG. 8.



From same case as No. 7 after lordosis had disappeared, and angular curvature commenced.

Deviations of the spine in a lateral direction may also occur in the early stage of destructive disease when it attacks the sides of the bodies of the vertebræ, or of the intervertebral cartilages, instead of their anterior aspects as usual; or in the later stages, it may exist as a consecutive curve, either above or below the angular projection, resulting from destructive disease in the lower cervical, or the lower dorsal and lumbar vertebræ.

Curvature of the spine, then, either in the anterior, posterior,

* In this woodcut the prominence of the spinal muscles in the lumbar region is less prominent than described, owing to the cast being taken in the sitting position.

or lateral direction, may coexist with destructive disease of the vertebræ in its early stage, without any reliable symptoms or indications of such disease being present.

Anterior Curvature of the Spine.

Lordosis—*λόρδωσις* from *λορδών* to bend supinely, so as to throw the head back. Curvature of the spine in an anterior direction, with the convexity in front, occurs chiefly in the lumbar region, as an increase of the natural curvature, from several causes; but it may also exist in the dorsal region to a less extent, and more rarely it occurs in the cervical region.

In the lumbar region this increase of anterior curvature is found—

1st. As a peculiarity in the natural conformation of the individual—often existing in several members of the same family, and hereditary. It is more common in some countries than in others, but in England I have most frequently observed it in short people, with long bodies and short legs, whose bony development exhibits some indications of a rachitic tendency.

2nd. As a constant effect of rickets in its more severe form, in which the entire skeleton indicates the existence of this affection in the stunted growth of the individual from arrested development of the bones—more conspicuous in the leg-bones from their normally rapid rate of growth during early childhood as compared with the spine and other bones of the body—and in various curvatures especially affecting the leg-bones and the pelvis. In severe rickets, the pelvis becomes flattened from above downwards, from the inability of its bones to support the superincumbent weight, and the sacrum assumes a horizontal direction. As a necessary result of this alteration in the direction of the sacrum, and the deviation in the axis of the pelvic cavity, an increase of the lumbar curve of the spine takes place to preserve the equilibrium of the body; and in these cases of rickets a very marked *lordosis* is the result.

3rd. As a constant effect of congenital dislocation, either of one or both hip-joints, an affection which occurs more frequently than is generally supposed. About forty cases, or probably

V. A. S. E. L. I. T. A. I.

more, have come under my notice since this affection was first pointed out to me, in the year 1845, by Dr. Carnochan, of New York, who when visiting in England, brought a case of congenital dislocation of both hips, in a boy, aged 18, to St. Thomas' Hospital, for the purpose of demonstrating this affection, to which he had paid much attention. The external characters of the dislocation, and its effects in altering the conformation of the chest and abdomen, in consequence of the tilting forwards of the pelvis, and the production of *lordosis* to an extreme degree in the lumbar region, were so strikingly illustrated in this case, that under the direction of Mr. South, an entire model of the boy was made by Mr. Kierney, and is now in the museum of the hospital. Fig. 9 is copied from a drawing of this patient in Dr. Carnochan's work on congenital dislocation of the hip-joint.*

This form of dislocation, in which the heads of the thigh bones are generally displaced upwards on the dorsum ilii, or upwards and backwards, appears to be very seldom diagnosed. Commonly no attention is directed to the condition of the hip-joints till some time after the period of walking, and then, when only one joint is affected, the limping of the child leads the surgeon to suspect the existence of hip-joint disease, and the case is treated accordingly. This error in diagnosis has occurred in several instances which have fallen under my observation.

* "Treatise on Congenital Dislocations of the head of the Femur," by J. M. Carnochan, M.D., New York, 1850.

FIG. 9.



Profile view of congenital dislocation of both hips, showing lordosis in lumbar region.

a. Anterior-superior spinous process of the ilium.

b. Trochanter major.

c. The incursion in the lumbar region.

f. The foot resting on the ground and directed forwards without inversion, or eversion, of the toes.

When dislocation of both hips exists, the real nature of the affection is generally overlooked, and I have known it said that the child would grow out of the peculiar waddling gait which characterises the walk in these cases. It is then, in congenital dislocation of both hips, that extreme incurvation of the lumbar region takes place, as a compensative effort to preserve the equilibrium of the body, disturbed by the tilting of the pelvis, which necessarily results from the abnormal position of the heads of the thigh bones.

4th. Either coexisting with destructive disease of the lumbar vertebræ in the early stage, as in the case already described, or as a consecutive curve after destructive disease has become arrested, and angular curvature, *i.e.*, posterior projection of one or more spinous processes, produced in the middle, or lower dorsal regions. In such cases the *lordosis* in the lumbar region is necessary to preserve the equilibrium of the body, and is, of course, persistent through life.

5th. As a constant effect of ankylosis of the hip-joint, with the thigh in a flexed position. After strumous disease of the hip-joint, rheumatic inflammation, and several other affections, ankylosis of the hip-joint, either ligamentous or bony, frequently takes place, with the femur in a flexed position, in most cases at an angle of about forty-five degrees, but sometimes at a right angle with the pelvis. The angle is generally much greater than is apparent at first sight, because in standing or walking, the patient brings the foot to the ground, by increasing the natural curvature of the spine in the loins, and in these positions, therefore, lordosis is produced, but it is more or less completely removable when the patient sits down. In such cases we have a greatly increased amount of flexibility in the lumbar region.

Treatment.

Surgically speaking, *lordosis* occurring in the lumbar region is of little importance, as in its worst forms it is only a part of a more important affection, and seldom becomes the subject of treatment; but it may sometimes assist us in the difficult diagnosis of destructive disease occurring in the lumbar vertebræ,

as it might have done in Mr. Lonsdale's case above described, had we known of the occasional coexistence of these affections and sometimes, though very rarely, it may become the subject of special treatment. In connection with the treatment of the diseases, such as rickets and caries which sometimes produce this form of curvature, I would direct your attention to a few practical points.

In the first class above described, viz., that dependent upon natural configuration or peculiarity, either of family or race, of course there could be no attempt at surgical interference.

In the second class—the rachitic form—no special treatment is indicated; but with the view of preventing this, as well as the more important pelvic distortion which accompanies it, I recommend as a general principle in cases of rickets, that the children be allowed to stand or sit as short a time as possible, and that reclining or complete lying down be encouraged. It is a serious, though common, practical error to send children in whom rickety curvatures have commenced, into the country, or to the seaside, and encourage them to run about all day long; such children return with improved health, but with the curvatures more confirmed. This is very good treatment for slight cases of knock-knees and bow-legs, which children may grow out of when the general health and strength are improved, but a great mistake in cases of true rickety curvatures, which we know are immediately produced by mechanical causes acting upon imperfectly nourished bones. I need not allude to the influence of muscular action, either in causing or increasing rachitic curvatures. The bones of the legs and the pelvis become distorted simply by the weight of the body, which they are unable to sustain, therefore, I remove this weight as much as possible, and substitute exercise in the horizontal, for exercise in the erect position, relying upon constitutional treatment, especially cod-liver oil with steel, and the hypophosphite of lime, &c., for promoting the cure of the disease.

Children may be induced to take a great deal of exercise, as amusement, by pulling themselves up and down an inclined plane with ropes, pulleys, and weights properly attached, as

will be represented in the lecture on treatment of lateral curvature. They should be kept in the open air, in the country or at the sea-side, as much as possible, and the reclining position in a properly arranged carriage should be encouraged. In many cases it may be impossible to carry this plan out as fully as could be desired, but if the principle be admitted, it may be adopted in all cases to a greater or less extent. We know that rickets, as a general rule, undergoes spontaneous cure with the increasing age of the child, and alteration of its diet; and that the bones become even stronger than healthy bones, but that the deformities remain persistent through life. It may be said that rickety children grow out of the disease, but they grow into the deformity. The danger in females of the pelvic distortion, of which the spinal curvature or *lordosis* is the least important consequence, I need hardly advert to, but I believe that all the rachitic distortions may be, to a great extent, prevented by the treatment I have mentioned.

In the third class, i.e., lordosis from congenital dislocation of the hip-joint, it is doubtful whether much permanent diminution of the spinal curvature can be effected by mechanical means, though I have seen it attempted, and have adopted this plan myself in several instances, with some appearance of benefit, by applying a spinal support with crutches and a webbing band passing in front across the chest and abdomen. The *lordosis* may be diminished by the constant use of a spinal instrument from early childhood to the completion of growth, but as the hip-joint articulations remain in their abnormal condition, the extent of the permanent advantage must be uncertain.

In the fourth class, i.e., lordosis existing during the progress of destructive disease in the lumbar region, or as a consecutive curve after destructive disease has subsided and angular curvature been produced in the middle or lower dorsal regions—there can be no doubt of the great advantage of mechanical support during the progress of caries or destructive disease in any region of the spine; and the case of *lordosis* coexisting with caries in its early stage in the lumbar region, previously

mentioned, affords a good illustration of the advantage of this plan of treatment. In all surgical works, as a general rule, the necessity of the patient lying down, during the progress of caries or destructive disease of the spine, is strongly insisted upon; but since my connection with the Orthopædic Hospital I have generally opposed this rule, and adopted the practice of applying mechanical support to the spine in most cases, by means either of a leather, or steel apparatus, according to age, and allowing the patient to walk about when so disposed. This treatment I find to be equally applicable to all stages of caries or destructive disease of the spine from its commencement, which we may in most cases diagnose before any angular projection has taken place, and even when the destructive process is evidently advancing, provided the patient be able to bear the support, and is disposed to walk. The mechanical support enables such patients to walk about with comfort, and does not in any way interfere with, but I believe essentially promotes, the proper constitutional treatment of the disease.

In old cases of *lordosis* in the lumbar region, or consecutive to caries and angular curvature in the dorsal region, no advantage is to be derived from treatment, the curvature being a natural compensating effort to maintain the equilibrium of the body.

In the fifth class, i.e., lordosis consecutive to hip-joint disease, the curvature is also a natural compensating effort to maintain the equilibrium of the body, and there are no indications for surgical interference.

Lordosis in Dorsal Region.

Lordosis may occur in the *dorsal region*, but to a much less extent than in the lumbar. Here it is frequently met with as a consecutive condition to caries, or destructive disease, after angular curvature has been produced either in the lower cervical, or in the lower dorsal and lumbar regions. Above or below the seat of disease, a flattening, and sometimes a deep sinking-in of the dorsal vertebræ frequently occurs. No surgical importance,

however, attaches to this form of curvature; but there is another form of *lordosis* occurring in the dorsal region, of considerable importance in a diagnostic point of view, to which I would direct attention. I allude to the sinking-in or depression of

FIG. 10.



Lordosis in dorsal region with very slight lateral deviation of the spinous processes.

the spinous processes, which takes place in some cases of double lateral curvature of the spine.

I had under my care in the hospital, a girl, aged 15; from Northumberland, in whom this form of lordosis existed in an unusually severe degree, as shown in Fig. 10, taken from a cast now in the hospital. The curvature was said to have commenced about five years ago, and its increase had been rapid. She was not short in stature, neither did she present any indications

of the rachitic development; excepting the curvature of the spine, she was well-formed, stout, and muscular, with every appearance of good health and strength; ruddy complexion, &c.

In this case, the posterior projection of the angles of the ribs in the dorsal region on the right side, corresponding to the convexity of the upper curve, and of the transverse processes of the lumbar vertebræ on the left side, existed to an unusual extent, and most certainly indicated a very severe degree of rotation of the bodies of the vertebræ, and therefore a larger internal curvature. The external lateral curvature, as judged of by the lateral deviation of the apices of the spinous processes, was not severe.

Such cases are frequently considered to be of a rachitic nature, but in the present instance I could see nothing to support such

an assumption, nor have I in many similar instances, which have come under my notice, unless it be admitted that rickets sometimes only attacks the spinal column. To this I should be unwilling to assent, if only from consideration of the fact that even in the worst examples of rickets, evidenced by all the peculiarities in the skeleton characteristic of this affection, there is no disposition to lateral curvature of the spine until obliquity of the pelvis has been produced by long-continued irregularity in the length of the legs from curvature of the long bones, and also by a bad mode of walking, induced by deformity of the feet—rachitic valgus.

Lateral curvature of the spine is evidently the last deformity in the order of time which occurs as the result of rickets, though I believe the opposite opinion is generally entertained. In all the worst cases of rickets in children now under my care, the spines are quite free from any lateral deviation—lordosis to some extent in the lumbar region only existing.

The *lordosis* in the dorsal region above described I am unable to trace either to the rachitic or any other constitutional cause; but the surgical interest which attaches to this deviation arises, not from its existence in severe cases of lateral curvature, but from the fact that it frequently occurs before any lateral deviation of the spinous processes takes place, and therefore before any lateral curvature has become obvious externally.

In such cases, some slight prominence of the shoulder is generally the reason of the surgeon being consulted, and finding no lateral deviation of the apices of the spinous processes, he usually gives a favourable opinion of the case. The *lordosis* probably does not amount to more than a loss of the natural posterior curvature of the spine in the dorsal region, *i.e.*, a flattening of the back, and a straight appearance of the spine, which he regards as of no importance.

Now, my reading of such a case would be that the prominence of the shoulder depends upon slight rotation of the bodies of the vertebræ, and that *internal curvature* of the spine already exists. Some additional confirmation of this view will be found in the fact that the angles of the ribs, on the side corresponding

to the projection of the shoulder, project a little posteriorly, when comparison is made with those of the opposite side, *i.e.*, the angles of the ribs on one side project, and on the other recede, and as this can only take place in consequence of rotation of the bodies of the vertebræ, the fact is of the utmost importance. The prominence of the shoulder, *i.e.*, the scapula, depends upon this posterior projection of the ribs on the corresponding side, and when this is considered in conjunction with the flattening or depression of the spinous processes in the dorsal region (without any lateral deviation), we may most confidently diagnose the existence of internal curvature of the spine, and the case should, without delay, be submitted to appropriate treatment.

Treatment of Lordosis in Dorsal Region.

Lordosis in the dorsal region consecutive to caries and angular curvature in the lower cervical, or in the lower dorsal and upper lumbar regions, does not require any special treatment. It is essentially a natural effort to restore the equilibrium of the body disturbed by the angular curvature, but if the destructive disease of the spine be treated during its progress, upon the principle of mechanical support previously described, I believe both the angular and the consecutive lordosis-curvature will be much less than it would be if no mechanical support had been adopted. Do not imagine that the object of mechanical support is in any degree to straighten or diminish by pressure the angular projection when formed; but if the spine be properly supported during the progress of destructive disease, the resulting angular curvature will not take place to a greater extent than absolutely necessary for curative purposes, *i.e.*, bony ankylosis, and therefore the consecutive curve will be proportionably small; whereas, without mechanical support, the angular projection is generally much larger than is necessary for curative purposes, and the consecutive curvatures are proportionably excessive, frequently producing an unsightly external deformity where very little need have existed.

With regard to the treatment of the other form of lordosis in the dorsal region which I have mentioned as existing in some cases of lateral curvature of the spine, this will be more fully described when the treatment of lateral curvature is considered.

Lordosis in the Cervical Region.

Lordosis occurs much less frequently in the cervical than in the dorsal or lumbar regions of the spine, and so far as I have observed, is nearly always the result of caries or destructive disease occurring in the upper cervical vertebræ, generally in children. The head is drawn backwards, and the face directed upwards; the larynx projects forwards, and it is hardly possible to feel the spinous processes of the cervical vertebræ at the back of the neck. Any attempt to alter the position of the head is accompanied with pain, as the disease is generally progressing when these cases are brought under our notice.

We may sometimes see *lordosis* in the cervical region as a persistent condition after the destructive disease has subsided, but then the position of the head is more natural than that above described; the frequency, however, with which caries in the upper cervical region terminates fatally, necessarily makes these cases very rare.*

In only one instance have I seen lordosis in the cervical region of congenital origin. In July, 1859, I was requested by the

* About two years ago I saw, in consultation with Mr. Lennox Browne, a remarkable case of lordosis in the cervical region in a gentleman, ~~set~~ about 50. The curvature was consecutive to caries, which had occurred in childhood, and no inconvenience had been experienced until the patient was over 40 years of age, when both deglutition and respiration began to be interfered with by increase of the curvature. The bodies of the cervical vertebræ projected into the throat, so that they could easily be touched by the finger. I recommended a mechanical support, and also tried partial suspension by the head, using Sayre's apparatus. When partially suspended, water could be swallowed easily, and the breathing was free. Finding relief, the patient practised complete suspension, though contrary to orders, and continues the practice of partial, or complete suspension at the present time, so that not only has increase of curvature been prevented, but it has been diminished to a sufficient extent to afford relief to all the urgent symptoms from which the patient suffered.

late Sir B. Brodie to see with him a child, Master G——, aged six months, who had been born in Florence, and exhibited an unusual combination of deformities, viz., talipes varus of both feet; imperfect flexibility of both knee-joints with lateral distortion, so that the legs were in the position of a severe case of knock-knees with the legs extended; probable absence of both patellæ, with some malformation of the condyles of the femur; very limited flexibility of both hip-joints, with tension of the adductor muscles, but so far as we could ascertain, without any dislocation or malformation at these joints; both hands contracted in form of club-hand; imperfect power of extension of both fore-arms, probably with some malformation of the condyles of the humerus, and with dislocation backwards of the radius; no muscular tension about the elbow-joints; contraction backwards of the head, with tension of the trapezii muscles, which when any attempt was made to draw the head forwards, became so prominent, that a deep central depression existed between them; the face was directed upwards, and the neck projected forwards; the spinous processes of the cervical vertebræ could not be felt.

This child could suck, but was only able to draw a very small quantity of milk at a time. The child was said to have been nearly asphyxiated at the time of birth, but was resuscitated by a brandy-bath. The legs were said to have been stiff and flexed upon the abdomen. The presentation was said to be natural. The child was of full proportions, rather above the ordinary size, and there were no indications of any cerebral defect or any muscular paralysis, or deficiency. The mother of the child, an English lady, above the ordinary stature, and well proportioned, met with a severe accident when four months advanced in pregnancy; she fell from some library steps, sideways across the back of a chair which caught her in the loins, in consequence of which she was laid up for a month.

In this case the *lordosis* was evidently dependent upon muscular contraction. At first I directed the child to be nursed with the head hanging forwards as much as possible, but when this position was continued beyond a very short time, the child

cried, as if in pain. Whilst these lectures were passing through the press, I was informed that the child died in the country, but no *post-mortem* examination was permitted.

Treatment of Lordosis in Cervical Region.

The *lordosis* in the neck either coexisting with, or consecutive to, caries of the cervical vertebræ, especially in children, does not admit of the application of mechanical support so easily as when situated in the dorsal or lumbar regions; but I have seen my friend Mr. Hoffman, of Margate, who follows out the principle of mechanical support during the active progress of disease of the spine more thoroughly than any other surgeon, so far as I know, very ingeniously contrive thick gutta-percha splint-like supports passing upwards from the shoulders, along the neck, to the occiput, so that the weight of the head is to some extent removed from the neck, and transferred through the large and strong splint directly to the shoulders, and all motion of the neck is prevented. I saw one case which Mr. Hoffman had most successfully treated in this way. In older children, or adults, a steel apparatus may be easily contrived and can be worn with great advantage.

Posterior Curvature of the Spine.

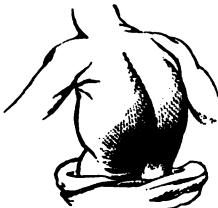
Cyphosis, κύφωσις, from κυφώω to bend or crook forwards.—Curvature of the spine in a posterior direction with the convexity projecting backwards, occurs chiefly in the dorsal region, as an increase of the natural curvature, from several causes, and is most frequently produced by muscular debility, or the long continuance of a stooping position as in certain occupations, &c.; hence this form of spinal curvature is most frequently seen in children and old people, but it may be produced by other causes at different periods of life.

In the cases which I propose to describe under the term of *posterior curvature* of the spine, it is not my intention to include that form of posterior projection of the spinous processes which

frequently assumes a more or less angular form, and in all surgical works is described as *angular curvature* of the spine, and which we know depends upon caries or destructive disease of the bodies of the vertebræ—*Pott's disease of the spine*, as it is also frequently called, because that distinguished surgeon especially described the pathology of this affection, and separated it from the other forms of spinal curvature with which it had been confounded by the earlier surgical writers. Let us now proceed to consider the different forms of *posterior curvature* which best admit of classification according to the different periods of life at which they occur.

1st.—*In Infancy* posterior curvature of the spine is the constant result of general debility, and weakly infants unable to sit up in the nurse's lap long after the period at which children generally hold themselves somewhat erect in the sitting position, are frequently brought to us. Sometimes such children do not appear to be imperfectly nourished—they may even be fat, and look well—but there is a general want of muscular power difficult to explain. At this early period of life the spine has not, as yet, assumed the antero-posterior curvatures in the dorsal and lumbar regions, and is normally straight. Muscular and ligamentous debility will therefore easily cause the spine to

FIG. 11.



Posterior Curvature of the spine in a baby in the sitting position as when nursed.

assume the form of a large posterior curvature when the sitting position is attempted, as represented in Fig. 11; if such a child were habitually nursed in the sitting position, and by a nurse who always carries the child on the same arm, a permanent deviation of the spine in the posterior direction would result, combined probably with some degree of lateral curvature.

TREATMENT.—Such cases are best treated by a combination of recumbency with local support to the spine and constitutional treatment. For local support I employ a very thick kind of leather, which when moist may be moulded to the form of the back whilst the child is lying down on its stomach—or a plaster

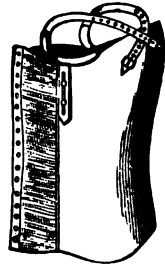
cast may be taken of the child's back in the same position, and the leather moulded on the cast. The leather becomes hard and unyielding when dry, and then softly padded is retained in its position by elastic material passing across the chest and abdomen, as shown in Fig. 12. Gutta-percha, perforated by small holes to prevent heat, may also be employed, but is not so good as the leather. I also direct the child to be nursed as much as possible in the reclining position, or recommend the use of a spinal tray made of basket-work, for complete recumbency, without applying any support.

Constitutionally I prescribe cod-liver oil with small doses of steel, but it is most essential to see that the child has a sufficient supply of good milk.

2nd.—*In Early Childhood, i.e.,* from two to three or four years of age, posterior curvature of the spine is frequently dependent upon muscular and ligamentous debility, in most cases probably only a continuance of the condition above described; but at this period cases not uncommonly present themselves in which a suspicion of caries or destructive disease of the spine exists, and the diagnosis may be difficult and uncertain. Such cases I have repeatedly seen terminate in angular curvature, after opinions against the probability of the existence of disease had been strongly expressed, so that a cautious opinion should always be given, and the cases carefully watched.

Another form of posterior curvature sometimes shows itself about this period of life which may be called *hereditary hump-back*, of which these two casts taken from two children, boys, in the same family, form good illustrations. The younger child was only two years of age when brought to me, and the posterior curvature in the upper dorsal region as exhibited in the cast was then confirmed, and evidently of a permanent character. The elder boy was five years of age when I first saw him, in April, 1852, and the cast from which Fig. 13 was taken,

FIG. 12.



Leather spinal support
for posterior curvature
in infants.

exhibits the severe amount of posterior curvature which existed

FIG. 13.



Hereditary hump-back in a boy
aged five years.

at that time. The child had been condemned to constant lying down, which it was found impossible to carry out, and therefore nothing had been done. His legs and arms are straight, so that there is no evidence of a rachitic condition, unless the curvature of the spine be regarded as such. The father is a short, dwarfish little man, with an extreme degree of hump-back. He walks tolerably erect, but his head appears to sink in between his shoulders, and his chest is much

deformed. The spinal curvature in his case began in childhood, and was not the result of caries of the vertebræ.

Before this gentleman was married, three medical men were consulted as to the probability of his deformity being hereditary, and a positive opinion against such a probability was expressed. However, the eldest son from whom the largest cast was taken, has proved to be the model of his father. The three next children are up to the present time free from any deformity, but the younger child, from whom the smaller cast was taken, exhibited the spinal curvature even at an earlier date than his elder brother. This child was placed on a donkey's back every day, in a kind of chair, and kept in the air as much as possible, but I need hardly say that the sitting position adopted was that most favourable to the increase of the spinal curvature.

Neither of these children exhibits any of the ordinary indication of rickets, and both appear to be strong and hearty. The mother is a tall, well-formed, and robust woman. The hereditary character of this form of curvature is sadly illustrated in this gentleman's family.

TREATMENT.—The general principles of treatment are the same as in the first class—viz., local support to the spine, with constitutional treatment, and the reclining position as far as may be practicable. In the case of the elder child above quoted,

I have employed a steel instrument, and maintained constantly a slight posterior pressure with great advantage. The child has been more than nine years under my observation, and most decidedly the spinal curvature has not increased in proportion to his growth, so that he is now much less deformed than when I first saw him, previous to which the increase had been rapid.

The leather spinal support which I employ at this period of life may be rendered more efficient by the addition of steel crutches attached to the leather; a form of apparatus which I use also in cases of caries of the spine with angular curvature in children.

3rd. *In Youth*.—Posterior curvature of the spine more frequently occurs in boys than in girls, and presents itself in the form commonly described as "*round shoulders*." Some boys have naturally a thick, clumsy, awkward figure, with high shoulders, and early acquire a habit of stooping, which, if not checked before eighteen years of age, settles into permanent cyphosis, or exaggerated posterior curvature in the dorsal region. This may sometimes be hereditary, but is more frequently only an acquired bad habit, and often coexists with an indolent, sluggish disposition.

TREATMENT.—These cases are best treated by the drill master and active gymnastic exercises, which are decidedly preferable to any mechanical support; but in girls, a well-contrived shoulder-brace, as shown in Fig. 14, is often useful, and sometimes I have been obliged to use a steel spring back-board of the T shape, or some such mechanical contrivance. In other cases I have employed an apparatus like that shown in Fig. 15, which consists of two steel springs, attached posteriorly to a pelvic belt, with a transverse bar at the upper part, and crutch-like horns instead of lateral steel crutches. This apparatus acts upon the principle of a posterior steel spring.

4th. *In the Middle Period of Life*.—Cyphosis, or an increase of the posterior curvature of the spine in the dorsal region, is not uncommon in the middle period of life, and may arise from various causes. Sometimes we see it as the result of

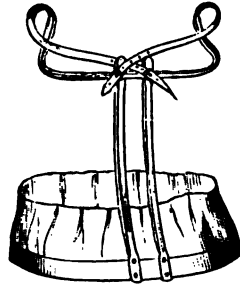
chronic chest affection, in individuals who have for several years suffered from bronchitis or some pulmonary complaint.

FIG. 14.



Shoulder Brace.

FIG. 15.



Steel support for posterior curvature with metal springs at back.

A severe form of cyphosis in the adult is not uncommonly the result of chronic rheumatism, the individual having a confirmed stoop and presenting the appearance of premature old age. In a few instances which have fallen under my observation, the termination of the case has proved the cyphosis to have depended upon caries or destructive disease of the spine when there were no symptoms by which the invasion of such a formidable affection could have been diagnosed. In one instance of this kind the true nature of the affection was not suspected till after the formation of psoas abscess.

In other cases cyphosis may be simply a continuance of the form just described as occurring in the period of youth, but in many cases the long-continued position from certain occupations is an obvious cause.

TREATMENT.—As a general rule, posterior curvature of the spine occurring about the middle period of life, may be more or less relieved by the patient wearing a double-crutch spinal instrument, with a strong webbing band connecting the crutches posteriorly, so as to exert a certain amount of pressure on the projecting portion of the spine. In cases where more

pressure is required, I have used with much advantage a spinal apparatus as represented in Fig. 16. This consists of a crescent-shaped pelvic-band, with hip-pieces,

FIG. 16.



Steel support for posterior curvature with spring plates at the back.

adjustable side-crutches (for counter-pressure), and a double back lever, to which is attached on either side spring plates of an equal size and supporting power.

5th. *In Old Age*.—Increase of the posterior curvature of the spine in the dorsal region, or cyphosis, in a severe and rigid form, is a frequent concomitant of old age, and may be the result of occupation, or debility. I have observed a severe form of cyphosis in old cavalry officers who have seen a great deal of service in India, and have attributed it to the fatigue of frequent and long marches commonly taken by the Indian army. Among the agricultural labourers of this country a severe form of cyphosis is of common occurrence; in very old men of this class it is almost constant, and among men from fifty to sixty years of age it is frequently witnessed, evidently as the result of their occupation at the plough and other field labour.

From these observations, then, it will appear that cases of cyphosis differ very much in their pathology, according to the different periods of life at which they occur, the classification I have made seems to be the least open to objection, but these cases, except at the earlier periods of life, and occasionally in the adult, present very little of surgical interest or practical importance.

LECTURE IV.

LATERAL CURVATURE OF THE SPINE, EXTERNAL CHARACTERS AND MORBID ANATOMY.

Let us now proceed to the description of the deformity generally called *lateral curvature of the spine*, and as it is only by an accurate knowledge of the pathology of this affection that we can hope to determine the principles of treatment applicable to the different classes of cases which present themselves to us in practice, I must ask you to follow me whilst I pursue the pathological investigation of this subject more in detail than many of my auditors might suppose to be necessary. I desire especially to direct your attention to various facts observed in post-mortem examinations I have had the opportunity of making, and to examine critically the more important theories as to the cause and mode of production of lateral curvature, upon which the different systems of treatment at present in use have been based.

Sufficient reason might be found for objecting to the continued use of the term "lateral curvature of the spine" in the fact that the curvature is never primarily or essentially in a lateral direction. Mr. John Shaw considered the term *serpentine curve* more strictly applicable; Sir Charles Bell described it as the *lateral or sigmoid*, or *complex curvature of the spine*; and Dr. Dods as the *rotated or contorted spine*; but I should be unwilling to suggest any alteration of a term which has been so long applied to this deformity, and which at once points to a well known form of *spinal distortion*, as

distinguished from the posterior or angular curvature always produced by *destructive disease*.

Lateral curvature of the spine, then, or as it is termed *scoliosis*, from σκολιόω *to make crooked*, may be defined as a distortion of the spine, in which the bodies of the vertebræ deviate laterally in a horizontal direction, with or without a corresponding deviation of the apices of the spinous processes. In many severe cases of scoliosis the spinal column presents on its anterior aspect a large sigmoid curve, whilst posteriorly very little deviation exists in the perpendicular line of the apices of the spinous processes; in slight cases, in which an internal curvature affecting the bodies of the vertebræ essentially exists, there may be no external curvature or lateral deviation of the apices of the spinous processes.

General Description of Cases included under the term "Lateral Curvature of the Spine"—weak Spines excluded.

By the definition above given you will perceive that in speaking of lateral curvature of the spine, I refer to a condition necessarily associated with certain structural changes, and I wish it to be distinctly understood that I do not believe in the existence of any fixed curvature of the spine, however slight, unaccompanied by such structural changes; in other words, I do not admit that lateral curvature of the spine ever exists merely as a functional condition.

According to the generally received opinion as to the mode of production of lateral curvature, this deformity is supposed to depend primarily and essentially upon muscular debility, with a lax condition of the ligaments of the spine; structural changes in the bones and intervertebral cartilages taking place only at a late period. No doubt muscular debility frequently coexists with spinal curvature as seen in young ladies from twelve to sixteen years of age, and in such cases it may be regarded as largely contributing to the production of curvature, but it is equally certain that lateral curvature of the spine as frequently exists in individuals who do not

exhibit any indications of muscular debility; and it is not uncommon to see this form of spinal distortion in girls, and also in boys of a healthy and robust appearance, associated with more than ordinary muscular strength. I have had three good examples of the latter class under my care in the hospital, in healthy-looking, muscular, country girls, whose physical condition appeared to many surgeons to be strangely opposed to the existence of spinal curvature. The fact, however, must be familiar to those who have had the opportunity of witnessing lateral curvature of the spine in a large number of cases, though as it does not well dovetail with their theory of the production of spinal curvature, such cases are probably passed over by them as exceptional, or as depending upon some obscure cause—rickets affecting the spine, for instance, often being assumed without a shadow of evidence—whereas they really ought to lead surgeons to criticise carefully the *muscular debility theory*, and to examine the general pathology of this affection.

On the other hand, it can hardly have escaped observation, how frequently general muscular debility exists in delicate boys and girls, often with a marked consumptive tendency, without any disposition to lateral curvature of the spine. It is certain that only a small per-centage of such delicate children with feeble muscular power, become the subjects of lateral curvature. I should say that of all the cases of lateral curvature which have passed under my notice, less than half of them have exhibited any marked indication of muscular debility.

In the description of lateral curvature of the spine, let it be understood, then, as being my intention to exclude a large class of cases frequently simulating lateral curvature, but which, I think, should be more properly grouped as a special series, and described as *weak spines, or cases of threatened lateral curvature*. Such cases present to us their chief points of interest in reference to the treatment to be adopted, rather than in their pathology; I shall therefore defer the special description of them until we consider the treatment of lateral curvature in its different forms, and the means of preventing it when such mischief appears to be threatened. It is doubtless true that of

these cases a certain proportion will terminate in the formation of lateral curvature, if this result be not prevented by proper treatment, and cases thus originating, will be included in my description ; but by many authors all such cases are absorbed into the class of lateral curvature, of which they are described as the first stage, and are given an undue importance. The result is, that they are unnecessarily submitted to a long course of treatment, such as is required only for cases of actual curvature. I have witnessed many examples of this kind, and after taking off spinal instruments which had been applied, these cases have progressed favourably under constitutional treatment, combined with gymnastics and partial lying-down, which alone they required. No doubt these cases yield abundant *cures* under any and every method of treatment, and there can be little doubt that the much-vaunted *cures of spinal curvature* have been largely derived from this class of weak spines, a curvature being assumed where no real curvature existed.

Let us now proceed with the description of cases of undoubted curvature of the spine, and first as to the

Arrangement and Nomenclature of Lateral Curvature, Single and Double Curvature in Different Regions.

Several forms of lateral curvature of the spine, as judged of by the more obvious external characters are generally described in books, the most frequent arrangement being into *single curves* and *double curves*, the single curve generally existing in the lumbar, but sometimes in the dorsal region, and occasionally involving both the lumbar and dorsal regions ; the double curve generally consisting of a deviation to one side in the dorsal, and a deviation in the opposite direction in the lumbar region, so that one curvature *compensates* for the other with more or less mechanical accuracy.

Triple curves, *quadruple* and *quintuple curves* are also described by those who aim at further refinement. In reference to the division into *single and double curves* it is only necessary to observe that anatomically it is impossible that any such

condition as a single curve can exist in the spine, so long as the individual is able to maintain the equilibrium of the body, and keep the erect position ; at each extremity of the so-called single curve, a return curve, or deviation in the opposite direction must take place, though externally, this may not be obvious ; however, as we certainly have the external appearance of single and double curves, and as the terms are well understood, there is some advantage in retaining them for descriptive purposes.

Other writers more frequently speak of *primary* and *secondary* curves, or as the latter are frequently called the *consecutive* or *compensating* curves, the secondary curve being supposed to take place after the primary curve, as a mechanical compensation for the latter ; but I doubt whether it can rationally be inferred, or in any way demonstrated by cases that a second curvature takes place after the first is formed ; to me it appears that both curvatures take place simultaneously, or very nearly so. It is evident that, as soon as a curvature begins to form, say in the lumbar region, the necessity for a second curvature immediately exists, for the purpose of maintaining the equilibrium of the body, and I believe such a curve as quickly begins to form. The rate of increase, however, will vary according to a variety of circumstances, and ultimately the appearance presented will approach more or less towards either the double or single form of curvature, and this will depend very much upon the equal or unequal length of the curves formed.

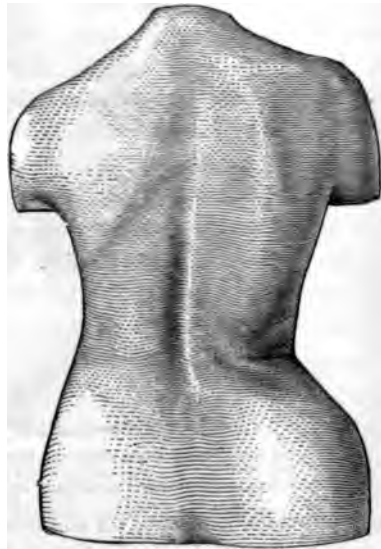
I would direct more attention than is generally given to the inequality in the length of the curves, because, in proportion as one curve increases and predominates, so the external deformity increases, and with it frequently the more severe symptoms, affecting the general health. Three or four short curves, of about equal lengths and therefore mechanically counterbalancing each other, may exist in a spinal column without producing more than a very slight external deformity, as in the specimen I now exhibit to you. Drawings from this specimen are represented in Plate II, Figs. 1 and 2, showing a

considerable degree of internal curvature coexisting with very slight external deviation of the spinous processes. Four vertebræ marked *a* have suffered lateral compression on their opposite sides, and in this spine, therefore, four short curves may be described as existing, and counter-balancing each other, so that the equilibrium of the body was maintained without any conspicuous external deformity. If, however, two curvatures of unequal length should exist, the longer curve is sure to increase with greater rapidity than the shorter, and must necessarily give rise to external deformity, as well as cause displacement of internal organs. The external characters will vary, then, according to the form and situation of the curvature.

External Characters in Single Lateral Curvature.

When *a single curve exists in the lumbar region* (I continue to employ the term with the explanation above given), and involves, as it generally does, the lower dorsal vertebræ, *a prominence of the hip*, corresponding to the concavity of the curve, is the most conspicuous external indication, and is itself diagnostic of this form of spinal deviation, as represented in Fig. 17. I have frequently been requested to examine young ladies simply on account of a prominence of one hip having been observed, perhaps by the dressmaker; at the same time being assured by the mother "that the spine is perfectly straight."

FIG. 17.



External characters of single curvature in lumbar region—Prominence of hip—Depression in the loin on one side, and increased prominence of spinal muscles on the opposite side.

Now in these cases, the *crest of the ilium becomes prominent*, simply on account of the abdominal walls in the lumbar region sinking in, as a result of the curvature of the spine in this situation, the depression or receding of the abdominal walls corresponding to the concavity of the curve; whilst, on the side opposite to the depression, and corresponding to the convexity of the curve, an increased prominence of the spinal muscles, especially the *sacro lumbalis* and *longissimus dorsi*, takes place.

The depression on one side and the prominence on the other, essentially depend upon rotation of the lumbar vertebræ, the effect of which is to alter the positions of the transverse processes, causing them to project posteriorly on one side, *i.e.*, on the convexity of the curve, and to recede inwardly on

FIG. 18.



External characters of single curvature in central portion of dorsal region in a case of moderate severity—Prominence of scapula and ribs on right side with deviation of spinous processes—Slight elevation of right shoulder and depression of the other.

the opposite side, *i.e.*, on the concavity of the curve, in consequence of which a prominence of the hip, or, more correctly speaking of the crest of the ilium, is produced. The diagnostic value of the prominence of the hip in these cases was especially

insisted upon by my late respected friend and colleague, Mr Lonsdale.*

A lateral deviation of the apices of the spinous processes generally exists in this form of curvature, but seldom in any very marked degree: the prominence of the hip, however, first and principally attracts attention. A disposition to sit awkwardly, with an occasional falling of one shoulder, may have been noticed, but this is by no means constant.

When *a single curve exists in the dorsal region* it generally involves a considerable length of the spinal column as shown in Fig. 18. The curvature is most conspicuous about the central,

FIG. 19.



External characters in severe case of single curvature occupying the entire dorsal region—Elevation of one shoulder and depression of the other—Prominence of the scapula and ribs on side of convexity of curve—ribs increased in obliquity and depressed in concavity of curve—chest deformed.

or the central and lower portions of the dorsal region ; but, in a severe case, the whole of the dorsal, and two or three of the lumbar vertebræ, are involved in one large curvature, as repre-

* "On Lateral Curvature of the Spine," by E. F. Lonsdale. Second Edition, page 46. London, Churchill. 1852.

sented in Fig. 19. The symmetrical form of the body is more disturbed in this than in any other form of lateral curvature, in consequence of the length of the curve, and its relation to the thoracic parietes.

The level of the shoulders is conspicuously altered, even when the curvature is slight, and as the deformity advances, *one shoulder becomes permanently elevated and the other depressed*. When attention is first directed to the inequality in the level of the shoulders, it is thought to be due only to a habit of the girl to raise one shoulder, but, in such cases, the so-called habit will generally be found to be produced by slight spinal curvature in the dorsal region.

A prominence of the scapula, corresponding to the convexity of the curve, always exists, and in many cases this is the indication first observed. *The scapulæ* will be found *unequally distant from the spinous processes*, that on the convexity being more distant than, and also raised above the level of the opposite bone.

A posterior projection of the angles of the ribs, on the side corresponding to the prominent scapula, and a depression of the angles of the ribs on the opposite side—depending upon rotation of the vertebræ—constantly exist, and as the curvature increases becomes one of the most conspicuous of the external characters.

The ribs become more oblique in their direction, and depressed laterally as well as posteriorly in the concavity of the curve, so that the chest sinks in, and becomes obviously deformed; on the convexity of the curve the ribs are more horizontal in their direction, and more widely separated from each other, than in their natural condition. This is well exhibited in the specimen represented in Plate II.

The apices of the spinous processes present a more marked lateral deviation in this than in any other form of curvature, though, even in severe cases, they afford but a very imperfect indication of the extent of the internal curvature as affecting the bodies of the vertebræ. In slight cases the lateral deviation of

the spinous processes may be scarcely perceptible, though the other external characters are sufficiently well marked.

When a single curve exists in *the upper and middle portion of the dorsal region*, it gives to the individual a high-shouldered and short-necked appearance, and produces a disposition to

FIG. 20.



External characters of single lateral curvature in the upper and middle dorsal region—
High shoulder and short neck—Trapezius muscle prominent and scapula tilted
forwards—Shoulders unequal in height.

stoop, as represented in Fig. 20. The scapula on the side of the convexity is tilted forwards, and the portion of the trapezius muscle just above the scapula is often very prominent, so much so, as to be occasionally mistaken for fatty or cystic tumour, or chronic abscess. In one case sent to me the surgeon had desired to open this supposed cystic tumour or chronic abscess. The same error in diagnosis I have known to occur in several cases in which the lumbar muscles have been remarkably prominent; and I would here only observe that all such muscular swellings convey to the touch a doubtful sense of fluctuation, which it is as well to be aware of.

External Characters in Double Lateral Curvature.

When a double curvature of the spine exists, one curve usually occupies the dorsal region, and presents its convexity to the right; and the other the lumbar region, with its convexity to the left side. The deviation to the right side in the middle dorsal region, as compared with the deviation to the left, occurs according to Bouvier* in the proportion of seven to one. When these curves are only of moderate extent, and *about equal in length*, so as to balance each other, as it were, and preserve the equilibrium of the body, *very little external deformity* exists—much less than in either of the single curves above described. The level of the shoulders is not disturbed, and therefore the same awkward way in sitting is not observed as in the other forms of curvature when one shoulder is higher than the other and the body twisted. Such curvatures are frequently unaccompanied by pain or other symptoms, and therefore allowed to become comparatively severe before the surgeon is consulted.

Young ladies having this form of curvature, pass very well in society, and are able to wear moderately low dresses without any notice being attracted to the existence of the deformity, the skill of the dress-maker easily concealing such defects in the figure when slight, as represented in Fig. 21. A medical examination will, of course, detect the anatomical deviations characteristic of the deformity.

The lateral deviation of the apices of the spinous processes is often very slight, even when the curvature, as affecting the bodies of the vertebræ, is rather severe, and affords no safe indication of the extent of the mischief. But the *natural posterior projection* of the spinous processes in the dorsal region is *either diminished or lost*, so that a *flattening* exists instead of a convexity, and, in some more severe cases, the spinous processes are depressed in the middle dorsal region, so that the natural curvature is to some extent reversed, as shown in Fig. 10,

* "Dictionnaire de Médecine et de Chirurgie Pratiques," tome xv. Paris, 1836. Art. Vertébrale.

described as lordosis in the dorsal region. This I regard as one of the worst features such a case can present.

FIG. 21.



External characters of double lateral curvature of the ordinary form, with prominence of right shoulder and right hip—Slight lateral deviation of spinous processes—Depression in right loin and prominence of muscles in left loin—Chest not much affected—Level of shoulders not disturbed.

The scapula will be found unequally distant from the spinous processes in these cases, when of moderate severity, the angle of the right scapula being further removed than the left, *i.e.*, assuming the convexity of the dorsal curve to present to the right side, as it does in a large majority of cases, and in some instances the angle of the right scapula will also be somewhat raised above the level of that of the opposite bone, but this is not so marked as in the other forms of curvature.

A posterior projection of the scapula, and a posterior projection of the angles of the ribs, upon which, indeed, the projection of the scapula essentially depends, are constantly present, on the convexity of the curve, in a degree proportionate to the extent of the internal curvature, or deviation of the bodies of the vertebræ.

A depression or sinking-in of the angles of the ribs in the concavity of the curve constantly exists to an extent corresponding to the posterior projection of the angles of the ribs on the side of the convexity; and, as a consequence of this depression of the ribs, the angle of the left scapula often appears abnormally conspicuous, though not really projecting further backwards. A posterior projection of the angles of the ribs in the dorsal region, on the convexity of the curve, and of the transverse processes of the lumbar vertebræ on the convexity of the lumbar curve, is in each region a more certain means of diagonalising the extent of the internal curvature or deviation of the bodies of the vertebræ, than the lateral deviation of the apices of the spinous processes, upon which it is customary for surgeons to rely.

The form of the chest may not be perceptibly altered in these cases when slight, but *generally the left breast is rather more prominent than the right*, and its aspect towards the left side rather than directly forwards. Sometimes it happens that the increased prominence of the left breast is the first thing noticed either by the girl or her mother, and on this account the surgeon may be consulted.

The external appearances in the lumbar region are not generally very conspicuous, in cases of moderate severity such as I have been describing, but there is *some prominence of the right hip*, corresponding to the concavity of the curve, and a *sinking-in of the right loin* in which the transverse processes of the vertebræ are felt at a greater depth than is natural. There is also a *posterior prominence of the spinal muscles on the left side* (that of the convexity of the curve) and a general fullness of the left side of the loin, and to some extent of the lower ribs on this side. The spinal muscles are rendered prominent on the convexity of the curve, chiefly by the posterior projection of the transverse processes of the lumbar vertebræ, resulting from the movement of horizontal rotation of the vertebræ which always takes place in such curvatures; the muscles are thus pushed out by the deviation of the bones, and, as the muscles on the convexity of the curve are also thrown into action to

resist increase of the curvature, the prominence is increased by their active tension.

Although all these anatomical deviations may exist in the dorsal and lumbar regions in a marked degree, and clearly indicate the extent and nature of the deviation as affecting chiefly the bodies of the vertebræ, *i.e.*, the internal curvature—yet the general effect as regards the external form and figure, is frequently slight and easily concealed even when the spinal curvature is rather severe. In this condition (the curves being about equal to each other) when the general health remains good, no further increase of the deformity may take place; spontaneous arrest may be said to occur, the affection remaining *in statu quo* through life; a liability to increase, however, remains, and may occur at any period of life from failure of general health, or from local causes, such as occupation, acquired habit of certain positions, &c.

When increase of the curvature occurs, the curves no longer remain of equal size, and failing to counterbalance each other, the equilibrium of the body is disturbed; the dorsal curvature generally increases to a much greater extent than the lumbar curve, and all the deviations above described become exaggerated—the scapula and the angles of the ribs on the right side project more posteriorly, and the right shoulder becomes disproportionately raised, and the left depressed to a corresponding extent. The lateral deviation of the spinous processes becomes more distinct, and often very considerable; but to this rule there are some remarkable exceptions. The form of the chest becomes altered, and in severe cases is much deformed, as shown in Fig. 22; the ribs on the right side become flattened in their convexity, and bent upon themselves a little in front of their angles, varying very much as to their degree of separation, and their horizontal or oblique direction; the ribs on the left side become depressed in an oblique direction downwards, so that the left side of the chest falls in, and a considerable hollow is formed; in the left pectoral region, the ribs project anteriorly, and the prominence of the left breast is increased to a corresponding extent. The external deformity, therefore, becomes

very considerable in such cases, as represented in Fig. 22. The increase of curvature in the lumbar region, although taking

FIG. 22.



External characters of double lateral curvature in severe case, with disproportionate increase of dorsal curve—Increased deviation of spinous processes, scapula, and angles of ribs, with deformity of chest and irregularity in level of the shoulders.

place to a less extent than in the dorsal, is accompanied by a corresponding increase of the anatomical deviations described in the slighter cases. The sinking in of the right loin increases, and the transverse processes of the lumbar vertebræ are at too great a depth to be felt; whilst on the left side, the prominence of the spinal muscles, and the general enlargement increases; the transverse processes on the left side (that of the convexity) can often be distinctly felt, as they sometimes rise to the level of the apices of the spinous processes.

When the form and situation of the spinal curvature vary from those just described, the external characters are modified accordingly, but it will be unnecessary for me to enumerate in detail all such deviations.

Let us now pass on to the consideration of the

Morbid Anatomy of Lateral Curvature.

The normal curvatures of the spinal column in the antero-posterior direction I have shown to depend upon the relative thickness of the intervertebral cartilages and bones in the different regions of the spine; and there can be no doubt that the abnormal curvatures in the lateral or other directions, when not connected with disease, also depend upon alterations in the relative thickness of the intervertebral cartilages and the bodies of the vertebræ at parts corresponding to the curvatures; but in the abnormal conditions, these deviations are associated with changes of direction in the articular facets of the oblique articulating processes. How these changes are brought about it will be for us to inquire, but I am now anxious to insist upon the fact that such structural changes must exist in every case of lateral curvature of the spine, however slight.

Let us therefore consider what are the precise deviations in direction assumed by the vertebræ, and the nature of the structural changes affecting the bodies of the vertebræ, the intervertebral cartilages, and the oblique articulating processes in lateral curvature.

General Direction and Form assumed by the Spinal Column in Lateral Curvature.

In the description just given of the *external characters* of lateral curvature in its different forms, I have already indicated the fact to which I would now more especially direct your attention, viz., that in lateral curvature, the spinal column does not yield in a purely lateral direction, as a flexible column would bend, but presents the appearance of a spiral twist, owing to the bodies of the vertebræ turning round in a direction of *horizontal rotation*, so that their anterior surfaces are directed laterally along the convexity of the curvature. In a severe case this rotation commonly extends to a quarter of a circle in the centre of the curve, and diminishes from this point to the two extremities, so that the vertebræ unequally turned upon themselves, cease to correspond in their natural

relations to each other, as well described by Bouvier. In a case of extreme severity this rotation will sometimes extend even to half a circle, so that in the centre of the curve the anterior surfaces of the bodies of the vertebræ have a directly lateral aspect; in such cases the angles of the ribs project posteriorly, and are bent sharply upon themselves, extreme deformity of the chest of course resulting.

This deviation of the bodies of the vertebræ does not necessarily correspond to, nor is it indicated by, any lateral deviation of the apices of the spinous processes. It may exist to a considerable extent—the rotation extending to a quarter of a circle in the centre of the curve—without any, or at least with very slight lateral deviation of the apices of the spinous processes, as shown by the preparation from which the drawings in Plates III., IV. and V. were taken. This specimen I removed, in accordance with a special permission given in a note left by the deceased, from the body of a distinguished member of our profession, the late Dr. Gideon Mantell, who died November 10th, 1852, aged 62, and whose name is so well known in connection with his discoveries in geological science.*

This case, together with the appearances presented on the post-mortem examination, and the dissection of the specimen, accompanied by lithograph plates, from which Plates III. and IV. in the present work are copies, was published jointly by Dr. Hodgkin and myself in the *Transactions* of the Medico-Chirurgical Society, vol. xxxvii., 1854. After describing the parts I removed, I observed:—"The fact of the greatest

* A brief memoir of Dr. Mantell, and a detailed account of his symptoms referable to the spinal affection during his protracted illness was written by my friend Dr. Hodgkin, from notes entered by Dr. Mantell in his diary, and accompanied the account of the post-mortem appearances written by myself, in the paper sent to the Royal Medico-Chirurgical Society. In addition to the description of the post-mortem appearances, however, only an inaccurate abbreviation of Dr. Hodgkin's account of the history of the case was published in the *Transactions* of the Society. The original MS., when applied for, was said by the Secretary of the Society, to have been destroyed: and as Dr. Hodgkin had not preserved a copy, many details of this very interesting case are now lost to science.

practical importance which this specimen illustrates and clearly proves, is one which I believe has not hitherto been described, viz., that a very severe degree of lateral curvature of the spine, with transverse rotation of the bodies of the vertebræ, accompanied with lateral absorption of the bones and intervertebral cartilages to a considerable extent, and attended with all the distressing symptoms of the most aggravated form of this affection, may exist, with only a very slight lateral deviation of the apices of the spinous processes; in short, that the severest degree of deformity of the spine may exist internally, without the usual indications in respect of the deviation of the spinous processes externally."

The importance of these facts in a diagnostic point of view, in reference to the history of this case, is then described. Practically it is of great importance to bear in mind that we may have a very large internal curvature of the spine, without any lateral deviation of the apices of the spinous processes; the slight deviation in these processes, seen in the specimen we are now examining, was not perceptible in the body, and is easily removed by pressure. This specimen probably exhibits the maximum in internal curvature with the minimum of external deviation; but essentially, I believe it very accurately demonstrates the series of changes which occur in every case of lateral curvature. In all the specimens which I have examined, preserved in the museums in London, I have found that the internal is much greater than the external curvature. There can be no doubt that this is the general rule, and so constant does it appear, that I have not yet met with any exception to it.

- The accompanying diagram (see Fig. 23) is intended to illustrate the horizontal rotation movement of the bodies of the vertebræ taking place, so that they deviate to the extent of a quarter of a circle, whilst the apices of the spinous processes deviate laterally only to a slight extent.

The thick transverse line B B represents the natural direction of the transverse processes of a dorsal vertebra in relation to the spinous process and body of the bone, through

which the line *A A* passes in an antero-posterior direction. These lines are therefore at right angles to each other, and represent the natural relations of the transverse to the spinous

FIG. 23.

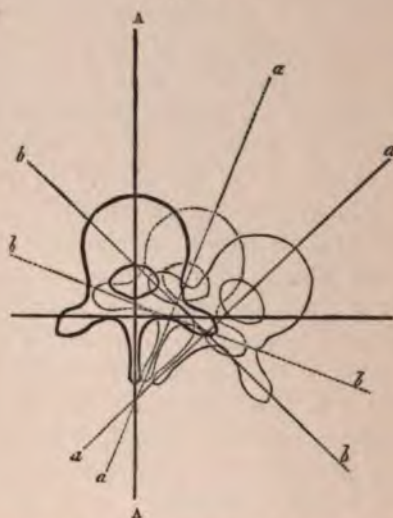


Diagram representing horizontal rotation of bodies of vertebræ, with slight deviation of apices of spinous processes; and showing altered relations of transverse processes, which gradually rise externally to the level of the spinous processes.

processes of the vertebræ. As rotation of the bodies of the vertebræ takes place as indicated by the lines *a a*, the relations of the transverse processes become proportionably altered, and their direction changed as indicated by the lines *b b*, till the extremities of the transverse processes on the convexity of the curve rise externally to the level of the apices of the spinous processes, as represented in the diagram.

If it be rare to find the extreme degree of internal, coexisting with an absence of external curvature, as in the case above described, it is undoubtedly true that internal curvature frequently exists to a slight extent without any external lateral deviation of the apices of the spinous processes; this is well exhibited in Plate II, and in the class of cases in which

this condition will be found there is said to be a prominence, or a *growing out*, as it is called, of one shoulder without any spinal curvature. The prominence, or *growing out* of the shoulder ought to be regarded as indicating the existence of internal curvature of the spine, rather than an unimportant external appearance depending, as it is generally said to do, upon enlargement of the muscles caused by excessive use of the right arm.

A little consideration, and the examination of specimens preserved in museums, will convince you that the spiral twist which the spine undergoes in lateral curvature, and which is due essentially to a *horizontal rotation* movement of the bodies of the vertebræ, must necessarily produce a *posterior projection of the angles of the ribs*, on the side of the convexity of the curve, in the dorsal region; and a *posterior projection of the transverse processes* on the side of the convexity of the curve, in the lumbar region, in a degree more proportionate to the extent of deviation of the bodies of the vertebræ; whilst in the concavity of the curve, the angles of the ribs in the dorsal, and the transverse processes in the lumbar region are depressed or sunk inwards to a corresponding extent; these conditions may be more certainly relied upon than the spinous processes, as indicating the existence of internal curvature or lateral deviation of the bodies of the vertebræ.

Diminution in height of the spinal column.—When lateral deviation of the spinous processes takes place—coexisting as it necessarily does, though not to a proportionable extent, with horizontal rotation of the bodies of the vertebræ—we have in addition to the posterior projection of the angles of the ribs in the dorsal region, and of the transverse processes in the lumbar region, a positive loss in height of the spinal column, proportionate to the extent of the lateral deviation; so that the general alteration which takes place in the conformation of the chest in severe cases of lateral curvature depends upon the combined influence of horizontal rotation of the bodies of the vertebræ and lateral flexion of the spinal column.

In addition to the spiral twist, and the diminution in height from lateral deviation, I will now direct your attention to

another peculiarity in the form assumed by the spinal column in lateral curvature, simultaneously with the other deviations, viz. :—

The obliteration of the natural curves in the antero-posterior direction.—In cases of double curvature of a moderate degree of severity, when unaccompanied by a stoop or falling forwards of the head from a curvature in the upper dorsal region, we may generally observe a flattening, and in some instances a positive depression, instead of the natural convexity in the middle dorsal region. To this I have previously alluded, when describing the external appearances in cases of double curvature, as one of the most unfavourable indications, as represented in Fig. 10; there can be no doubt that it depends upon rotation of the bodies of the vertebræ, also indicated in these cases by the altered relations of the angles of the ribs, and therefore it is a certain and reliable evidence of the existence of internal curvature of the spine, necessarily accompanied by certain structural changes, even though there may be very slight or no lateral deviation of the apices of the spinous processes. In the more severe cases of curvature with conspicuous external deformity, a careful examination will show that the prominence on the side of the convexity essentially depends upon the posterior projection of the angles of the ribs, and even in these cases there is frequently no posterior projection of the spinous processes. In some cases, however, especially in what are called *large single curves*, accompanied by a stoop, the spinous processes project posteriorly in the general yielding of the spinal column.

In lateral curvature in the lumbar region, the normal curve in the antero-posterior direction is frequently obliterated, this portion of the spine appearing in profile view to be remarkably straight, instead of presenting its naturally curved outline.

In articulated skeletons and dried specimens exhibiting spinal curvature, this obliteration of the natural curves of the spine in the antero-posterior direction may be traced not only in the spinous processes, but in the outline formed by the bodies of

the vertebræ when viewed in profile. Sometimes the natural curvatures are even reversed, and this was remarkably conspicuous in the specimen represented in Plates III., IV. and V. In my description of this specimen in the *Medical and Surgical Transactions*, I observed, "Viewed in profile, or from its lateral aspect, the natural curve of the spine in the lumbar region is seen to be reversed, and instead of presenting a convexity forwards, the three upper lumbar vertebræ, together with the twelfth dorsal, present anteriorly a concave outline. This is not produced by any absorption or destruction of the bodies of the vertebræ anteriorly, but is evidently caused by the very remarkable degree of rotation above described, by which the natural anterior convexity in this region is made to assume a lateral position, as if the spinal column had been laterally twisted on its vertical axis, the centre of motion being fixed at the apices of the spinous processes."*

The general effect of this obliteration of the normal curves in the antero-posterior direction is to produce externally the appearance of a straightening of the spine as far as the profile view of the apices of the spinous processes is concerned, and in examining cases of spinal curvature we may frequently notice this condition.

The description now given of the general form assumed by the spinal column in lateral curvature has no great claims to novelty or originality, since the same appearances have been described, with more or less accuracy, by several writers, but the existence of internal without any external curvature, or lateral deviation of the apices of the spinous processes, either in severe or slight cases, and the means of detecting this deviation have not been previously described so far as I am aware. All authorities on spinal curvature who have described rotation of the vertebræ, regard this condition as a late change,

* *Op. cit.*

a complication, or a superadded condition of lateral curvature, which they consider essentially to be a lateral deviation of the spinal column caused by a muscular weakness before rotation takes place; but the view I have been led to adopt is, that rotation takes place at the commencement of spinal curvature, and forms an essential part of the series of structural changes which must necessarily exist in slight as well as in severe cases, and that the external lateral deviation follows rather than precedes the rotation movement.

Historical Notices of Horizontal Rotation of the Bodies of the Vertebrae in Lateral Curvature.

The first mention I have met with of rotation of the vertebrae in lateral curvature, occurs in a somewhat remarkable book published by the late Dr. Dods, of Bath, in the year 1824, entitled "Pathological observations on the rotated or contorted spine, commonly called lateral curvature."* The author endeavours to prove that the condition generally described as lateral curvature is really one of transverse rotation of the vertebral column, the natural antero-posterior flexures of which are by this movement brought more or less into view, laterally instead of posteriorly; that, in fact, as an object becomes changed in its appearance from change of position or by varying the point of sight, so an altered position, the result of rotation of the spinal column, produces the deceptive appearance of lateral curvature. At page 23 he remarks, "As the spine is rotated spirally, and not as upon a pivot, the profile of its flexures will be imperfect;" and in this way he explains the existence of only one or two curvatures. As to the mode by which he was led to these conclusions, Dr. Dods observes at page 101, "During the course of my operations [alluding to friction, &c.] upon several patients, I was struck in all of them (for they were all contorted to the right side)

* "Pathological Observations on the Rotated or Contorted Spine, commonly called Lateral Curvature." By Andrew Dods, M.D. London: dated January 2, 1824.

with a considerable bony hardness and projection on the left side of the loins, raised nearly to a level with the spinous processes; and this I found to be the case in the patients whose spine exhibited *little or no apparent curvature in the loins*, as well as in those in whom the apparent curvature was very great." After the muscles had been relaxed by friction, Dr. Dods was enabled to satisfy himself that the bony prominences were produced by the transverse processes of the lumbar vertebræ, which could be distinctly felt and counted like the spinous processes. In these cases the transverse processes of the same vertebræ on the opposite side could not be felt, and appeared to have sunk inwards completely out of reach.

Reasoning upon these facts, and considering that a direct lateral curvature of the column could only affect the transverse processes by separating them on one side and approximating them on the other, without altering their transversity with respect to the body, Dr. Dods concluded that such a condition could only be produced by a movement of transverse rotation. Thus it would appear that Dr. Dods arrived at his conclusions—we may say his theory—by inference from certain facts observed by him while rubbing his patients, and much credit is undoubtedly due to him for careful and original observation; though the explanation of the phenomena observed, their mode of production, and the indications for, and methods of treatment given, are in many respects erroneous.

No dissections or post-mortem examinations are recorded by Dr. Dods, nor does he allude even to skeletons or specimens as exhibiting the rotation he correctly inferred to exist. This at once offers a sufficient explanation of rather an important discrepancy between the account given by Dr. Dods of this rotation as affecting the direction of the bodies of the vertebræ, the spinous and the transverse processes, and the diagram by which he illustrates his description. In the diagram a considerable curvature of spine to the right side through the dorsal region is represented; the apices of the spinous processes deviating to the right, but the bodies of these processes lying obliquely and directed towards the left, therefore the

bodies of the vertebræ must also be directed towards the left side—the concavity of the curve; but there can be no doubt that in all such cases the bodies of the vertebræ are invariably directed towards the side of the convexity of the curve.

As to the cause and mode of production of this condition of rotation, Dr. Dods believed it to be produced by active muscular contraction of the extensor muscles of the spine, acting from the fixed pelvic bones upon the transverse movable levers, viz., the ribs and transverse processes of the vertebræ. The active muscular retraction described is not supposed to be spasmodic, or to depend upon any abnormal condition of the nervous centres, but to result from frequent and protracted voluntary muscular efforts to keep the body in the erect position under the restraining influence of school discipline. This state of constant contraction of the spinal muscles is supposed to lead to their disorganisation by producing, “in the first place, debility; secondly, a wasting of their substance; and lastly, permanent contraction of their fibres.”—Page 78.

The late Mr. John Shaw does not describe this condition of rotation of the spine in his excellent treatise on “Distortions of the spine,” published in 1823,* but in his second work entitled “Further Observations,” &c., published in 1825, page 8, and also in the folio volumes of plates, with descriptions, published by him in 1824, page 3, later in the year than the publication of Dr. Dods’ book, to which he makes some severe critical allusions, Mr. J. Shaw describes the altered relations of the scapulæ as depending upon “that peculiar twist of the spine on its axis which has been scarcely observed by any author, although it always accompanies even the slightest degree of serpentine or lateral curvature.” It does not appear however, that Mr. J. Shaw attached any practical importance

* “On the Nature and Treatment of the Distortions to which the Spine and Bones of the Chest are subject.” By Mr. John Shaw. London, 1823. Also, “Further Observations on the Lateral or Serpentine Curvature of the Spine,” &c. By Mr. J. Shaw. London, 1825. And “Engravings Illustrative of a Work on the Nature and Treatment of the Distortions,” &c. Folio. By Mr. J. Shaw. London, 1824.

to this condition of rotation, nor does he attempt any explanation of it; this was reserved for his brother, Mr. Alexander Shaw, whose observations on this subject I shall presently advert to, when describing the structural changes which occur in this deviation.

Bouvier, in his detailed and accurate description of the pathological anatomy of lateral curvature,* describes rotation as existing only in the severe forms of curvature, but alludes to the want of correspondence between the external and internal deviations.

From an observation made by Sir B. Brodie, in a clinical lecture on lateral curvature, delivered by him in December, 1846, and published in the *London Medical Gazette*, it would appear that M. Guérin had observed the coexistence of rotation of the bodies of the vertebræ with very slight deviation of the spinous processes. Sir B. Brodie observes, "At a very early period, and even before the lateral curvature is very distinct posteriorly, the bodies of the vertebræ are actually twisted to one side. This curious circumstance was pointed out to me by M. Guérin, who has some preparations in which the fact is very perceptible." M. Guérin, in his memoir published in 1843,† page 18, alludes to the modifications of form dependent upon the double influence of vertical displacement caused by lateral flexion, and of horizontal displacement caused by torsion. He was evidently aware of the existence of rotation, and had noticed the disproportion between the internal and external curvatures, but he does not allude to rotation of the bodies of the vertebræ as at any time coexisting with an absence of lateral deviation of the apices of the spinous processes, or as occurring in the early stage of lateral curvature; therefore it is not mentioned in its most important practical bearing upon the diagnosis of internal curvature,

* "Dictionnaire de Médecine et de Chirurgie Pratiques." Supplément, S. 2. u, ione—Zinc. tome 15, à Paris, 1836. Artic. Vertébrale (Déviations de la Colonne), par Bouvier.

† "Premier Mémoire sur le Traitement des Déviations de l'Epine par la Section des Muscles du Dos," par Dr. Jules Guérin. Paris, 1843.

in cases in which the external indications generally relied upon as diagnostic by surgeons are absent.

The same remarks may be made on the observations of Sir C. Bell, who has accurately described the rotated condition of the spine in lateral curvature in the following words:—"It must be especially observed that this distortion of the spine is not merely a lateral curve, the column is twisted or twined on its long axis. The effect of this is very particular. First, in the loins it causes the transverse processes of the lumbar vertebræ of the left side to project, so as to thrust out the long muscles of the back, and chiefly the *longissimus dorsi* and *sacro-lumbalis*. Whilst a fullness by this means is presented on the left side of the spine, in the loins, there is a flatness or hollow on the right side. Exactly the reverse of this takes place in the upper part, or the dorsal vertebræ. The spine is turned round from right to left below, and from left to right above. See the judicious remarks of Mr. A. Shaw on cutting the muscles of the back, Note vii."* Diagrams illustrating the effects of the upper twist upon the conformation of the chest, made by Mr. A. Shaw, are then given, and will be again adverted to when the effect of the spinal curvature upon the chest is described.

In the more recent works on lateral curvature, less attention has been paid to the subject of rotation of the vertebræ than in the writings to which I have referred, and in none of them is more importance attached to it than as a late effect, or complication of lateral curvature in severe cases of long standing; but I feel convinced that the examination of specimens of lateral curvature, and a consideration of the anatomical and mechanical construction of the spinal column, will lead you to agree with me in attaching the highest degree of clinical importance to these deviations in the bodies of the vertebræ, and the alterations in the oblique articular processes upon which they depend, more especially in reference to the diagnosis and treatment of slight cases of spinal distortion.

* *Practical Essays*, by Sir Charles Bell. Edinburgh, 1842.

LECTURE V.

LATERAL CURVATURE OF THE SPINE; MORBID ANATOMY CONTINUED.—CHANGES IN BONES AND CARTILAGES.— DEFORMITY OF CHEST AND PELVIS, &c.

Let us now proceed to examine

The Nature of the Structural Changes Affecting the Bones and the Intervertebral Cartilages.

The earliest structural changes which occur in lateral curvature of the spine are traceable, and I believe take place simultaneously, in the intervertebral cartilages, and at the articulations formed by the oblique articulating processes. These changes are essentially the result of atrophy and absorption, produced by the long continued irregular distribution of the superincumbent weight of the head, upper extremities, and thorax.

The intervertebral cartilages suffer from unequal compression, and become more or less wedge-shaped according to the severity and duration of the curve, the thinning of the cartilages corresponding to the concavity of the curve; this condition is well exhibited in Plate V. In the anatomical and physiological observations I have already adverted to the effect of equal and unequal pressure upon the intervertebral cartilage. I will here only remind you that in the vertebral column we have nearly four inches in height of this soft elastic tissue, which, during the day, when equally compressed, diminishes in height or thickness from half to three-quarters of an inch, so that during the day we lose from half to three-quarters of an inch in

height; but this is regained during the night, when the weight is completely removed by the recumbent position. If, however, during the day the intervertebral cartilages should be unequally compressed in consequence of any long-continued disturbance of the equilibrium of the spinal column from any cause, the cartilages do not completely recover their natural form during repose, but remain permanently reduced in thickness by the compression in the concavity of the curve.

The nature of any structural changes which the intervertebral cartilages may pass through as they become thinned by irregular compression, has not, so far as I am aware, been determined; but from several specimens in the more advanced stages, which I have examined microscopically, I have no doubt that these changes are essentially of an atrophic and degenerative character.

The bodies of the vertebræ become more or less wedge-shaped, as exhibited in Plate V., but at a much later period than the intervertebral cartilages. It is, however, a very common error to suppose that the bodies of the vertebræ become altered in form only in severe cases of curvature of long duration. In slight cases of lateral curvature, when the deformity has existed a sufficient length of time, probably one or two years, the bodies of the vertebræ become perceptibly altered in form. In the specimen of slight lateral curvature which I now exhibit to you, the diminution in thickness both of the intervertebral cartilages and the bodies of the vertebræ in the concavity of the curves may be distinctly seen. This specimen, one of slight lateral curvature, is represented in Plate II., and the bodies of four vertebræ which have suffered compression are indicated by the letter *z*. Length of time, then, rather than degree of curvature, is essential to the production of these changes.

The bodies of the vertebræ do not on section present any unhealthy appearance—at least in the late stages at which I have examined them, and there are no reasons for suspecting any changes in the texture of the bones at an early period. In cases of long duration, I have observed that the bones increase in solidity in the concavity of the curve; the cancellous texture

of the bodies of the vertebræ on the compressed side becomes more compact in appearance, and the thin layer of compact bone which naturally forms the shell, or outer surface, of the bodies of the vertebræ, becomes increased in thickness and density, so that it may be said to be replaced by a thick wall of bone of ivory-like appearance. This is shown in the specimen, a section of which is represented in Plate V. These changes are essentially of a conservative nature, and are calculated to arrest the progress of the curvature.

The oblique articulating processes, and more especially the articular facets on these processes, which form the only *direct articular connections* between the separate bones of the vertebral column, undergo important structural changes at an early period of the formation of lateral curvature, I believe even at its commencement. In the specimens of lateral curvature which I now exhibit to you, as well as in all the specimens in museums, you may observe that the articular facets situated on the oblique articulating processes, are altered in direction and aspect, according to the extent of the lateral deviation of the bodies of the vertebræ. In the lumbar region where these articular facets are naturally nearly vertical in direction, looking inwards and outwards respectively, they gradually become, in severe cases of lateral curvature, changed in direction, so that they face obliquely upwards and ~~downwards~~, and ~~downwards~~ and outwards.

In the specimen represented in Plates III., IV. and V., this alteration is very remarkable, and well shown in Plate III., but more or less it exists in all cases, and a little reflection on the anatomical construction of these articulations will show you that it is impossible for any persistent deviation in the form of the spine to take place without an adapted alteration in direction of these articular facets. In severe cases, of long standing, such as that to which I have just alluded, the oblique processes themselves become much altered in form, and sometimes, as in this instance, present an irregular enlargement and nodulated appearance surrounding the margins of the articular facets; changes apparently similar to those by which

the articular extremities of the bone become enlarged in what is termed "chronic rheumatic arthritis."*

These important deviations in the oblique articulating processes appear to have escaped the attention of nearly all writers on spinal curvature, and even in the works of the late Mr. John Shaw, published in 1823 and 1825,† which decidedly contain the most accurate pathological description and general account of lateral curvature in the English language, I do not find any mention of these deviations; but Mr. Alexander Shaw, who was long engaged in the same field of inquiry with his late brother, and also with his relative, Sir C. Bell,‡ has accurately described the changes to which I allude, and adduced them in explanation of the rotation of the bodies of the vertebræ which had been previously observed by Mr. J. Shaw, and described at a later period by Sir C. Bell. Mr. A. Shaw's description is so clear and exact, and has been so completely confirmed by my own observations, that I make no apology for extracting the following quotation:—

"If we attend to the natural structure of the spine it will be seen that whilst we lean the body to one side, the pressure is thrown, almost exclusively, upon the articulating processes of that side; these processes delicate as they are, being the only bony structures which check the lateral movements of the trunk. Hence, when a habit is acquired of inclining to one side, or of resting upon one hip, as in sitting, the sharp edges of these small joints of bone receive the weight of the entire body. But as the articulating processes are remarkably soft, and imperfectly formed at the age of puberty, it follows that they will become wasted by absorption when this position is long persisted in, and an inequality of the length of these two lateral props, on which

* For a description of these changes see a paper by the author in the *Trans. Path. Soc.*, vol. iii., and in the lithograph plate accompanying the paper, the microscopical characters observed by him in this process of articular enlargement are represented.

† *Op. cit.*

‡ "Practical Essays," by Sir C. Bell, Edinburgh, 1842. With "additional observations," by Alexander Shaw.

the vertebræ rest posteriorly, will be the consequence, those of the concave side being shorter than those of the convex. 5th. In lateral curvature of the spine, we have a distinct demonstration that the articulating processes give way more extensively than any of the other parts of the column. This is evinced by the rotation which the spine makes in its perpendicular axis, at the same time that it inclines laterally. The joints of the articulating processes being situated posteriorly, as well as laterally, the spinal column cannot yield in their direction, without wheeling partially round; and it is owing to this rotation that the transverse processes, and the ribs, are directed obliquely backwards upon the convex side of the curvature, thus giving rise to a fullness or swelling on the one hand, and a depression or sinking inwards on the other.”*

This is the earliest description I have been able to find of the appearances to which I now desire to direct your attention, and it is somewhat remarkable that it has not attracted the notice of any subsequent writer on the subject of lateral curvature. Even Sir Charles Bell, who wrote ten years later, and carefully described the rotation of the vertebræ as a most important element in the distortion, passed by unnoticed the facts described by his relative, Mr. A. Shaw, in the explanation of the production of this rotation. To me it appears that the account above given by Mr. Shaw of the mode in which the structural changes affecting the oblique articulating processes are induced, affords a satisfactory explanation of the way in which the rotation of the bodies of the vertebræ is produced, while at the same time it is quite in accordance with my own observations.

The transverse processes are altered both in direction and form. In their general direction and relation to the soft parts they are altered as a result of the horizontal rotation of the bodies of the vertebræ, so that when the curvature is in the lumbar

* *Medico-Chirurgical Transactions*, vol. xvii. London, 1832. See a paper on “A peculiarity in the conformation of the skeleton in rickets,” by Alexander Shaw. Page 466.

region, the transverse processes in the concavity of the curve are depressed towards the abdominal cavity, and in a severe case cannot be felt by external examination; whilst those on the convexity of the curve project backwards towards the skin, and in a severe case, as that represented in Plates III., IV. and V., rise to the level of the apices of the spinous processes, and can readily be felt along the outer margin of the spinal muscles, which they also protrude backwards and render prominent. The diagram-outline represented in Fig. 23 is intended to illustrate the altered relations of the transverse to the spinous processes.

The deviation in direction of the transverse processes is extremely important in a diagnostic point of view, and will enable you with certainty to diagnose a curvature in the lumbar region in cases in which no lateral deviation of the apices of the spinous processes exists. Plate III. especially illustrates this condition. The transverse processes it should also be mentioned, become widely separated from each other on the convexity, and approximated to each other on the concavity of the curve.

The transverse processes become materially *altered in form* in severe cases of long standing, as exhibited in Plates III. and V. They may become attenuated and project backwards in a curved or horn-like form, with a varying inclination upwards or downwards—a change apparently produced by the long continuance of irregular muscular action; or, when from the severity of the case, one or two of these processes belonging to the lower vertebræ, rest upon the crest of the ilium, they may become flattened from above downwards, by the mechanical pressure of the superincumbent weight. In the case represented in Plates III., IV. and V., the transverse process of the fourth lumbar vertebra on the left side rested on the crest of the ilium, and was not only flattened from above downwards, but also bent upwards by pressure (shown in Plate III.) and on its flattened and expanded extremity a surface, covered by fibro-cartilage, rested upon, and formed an abnormal articulation with the crest of the ilium. The transverse process of the fifth

lumbar vertebra in this case was sawn through in removing the parts, but must have been much distorted and altered both in direction and form.

Supposed dependence of these Alterations in the Bones upon Rickets.

I have now enumerated the structural changes affecting the bones and the intervertebral cartilages, which, I believe, essentially and necessarily exist in all cases of lateral curvature of the spine, however slight; but varying, of course, in degree according to the severity and duration of the deformity. An important practical question arises at this point of our inquiry, viz :—

Do the structural changes above described, as affecting the bones and intervertebral cartilages in lateral curvature, occur equally in all classes of cases, or only in those associated with, or supposed to depend upon rickets? Contrary to the opinion of some writers on spinal curvature, I believe the structural changes above described occur equally in all classes of cases, and, moreover, that there is no special liability to lateral curvature of the spine in cases of rickets consequent upon the condition of the bones of the vertebral column in this affection. In this opinion I differ from the late Mr. Tamplin, who states that, “in the greater number of cases, the bones of the spine, ilium, or chest, do not suffer; the affection is but a simple malposition, implicating, more especially, the passive attachments or ligaments, and the position of the muscles When the curvature commences under five or six years of age, as it commonly does in rachitic cases, an actual compression of the bodies of the vertebræ occurs, in the concavity of the curve.”* And again at page 11, “the curve with rachitic combination is of all others the most serious, inasmuch as here the bones are incapable of performing their proper functions; that is, of acting as a support and fulcrum for the muscles, without yielding in the one or the other direction. In such cases an actual

* “On Lateral Curvature of the Spine,” by R. W. Tamplin, page 16. London, 1852.

alteration of the bones takes place, so that they present a serious addition to the simple malposition common to other cases, as well as a more severe distortion of the spine and chest, than either of those to which I previously alluded. It is by no means uncommon to find this rachitic state associated with tubercular disease."

It has been too much the custom of writers on spinal curvature to assume that cases of severe lateral curvature occurring at an early age, and in which the bones necessarily become much altered in form, are essentially of a rachitic nature; I believe a serious practical error is involved in this opinion, from an imperfect consideration of the evidence which should induce us to assign these cases to the rachitic classes of deformities. The question is worthy of our attention and consideration, and I believe the line between the rachitic and other classes of lateral curvature of the spine cannot, for practical purposes, be drawn too broadly, because the rachitic is the only form of lateral curvature associated with deformity of the pelvis, and therefore, the only form in which any danger in child-bearing need be apprehended, or any obstacle to marriage be assigned upon medical testimony.

The most severe cases of lateral curvature of the spine occurring either in childhood or in youth, which have come under my observation have certainly not been connected with rickets. The children in these cases have not presented the ordinary appearance of rickets either in their general conformation, or in the peculiarities affecting the long bones which are constantly present in cases of rickets.

Unless we have present these peculiarities in the conformation of the skeleton and condition of the bones, which have been so ably described by Mr. A. Shaw* as essentially characterising the rachitic condition, I believe we are not justified in assuming that a case of lateral curvature, however early it might occur, or however severe it may be, depends upon rickets.

* "On the Peculiarity in the Conformation of the Skeleton in Rickets," a paper by Mr. Alexander Shaw, in vol. xvii. of the Medico-Chirurgical Society's *Transactions*. London, 1832.

The most severe cases of lateral curvature I have seen in children have not presented any of the indications, but appeared to depend essentially upon constitutional causes, generally associated with an hereditary disposition to curvature of the spine, frequently running through two or three generations, and connected with a history of a tendency to consumption in the family.

The observation of Mr. Tamplin above quoted, viz., *that the rachitic lateral curvature commonly commences under five or six years of age, and that it is by no means uncommon to find this rachitic state associated with tubercular disease*, appears to prove that cases are alluded to which can have but little claim to be considered as depending upon rickets, and are, doubtless, the same as those to which I have adverted as depending principally upon constitutional causes, generally associated with an hereditary tendency. I need scarcely observe that the connection here assumed to exist between rickets and tubercular disease, is opposed to all modern pathology. The highest authorities on rickets agree that this affection is in no degree dependent upon, or connected with, tubercular disease, and generally it is considered that these affections are antagonistic to each other.

The early period, at which lateral curvature of the spine is said to take place, viz., under five or six years of age, in cases of rickets, is entirely opposed to my own experience and observation, which lead me to the opinion that lateral curvature occurs in such cases at a late, instead of an early period—generally after ten or twelve years of age, and sometimes much later—and depends more upon the inequality in the length of the legs from rachitic deformity (as well shown in the skeleton from which Fig. 24 was taken) than upon any morbid condition of the vertebræ. I believe we may safely conclude that no special liability to lateral curvature exists in cases of rickets in consequence of any abnormal condition of the bones, an opinion in which the late Mr. Stanley, one of the highest authorities on diseases of the bones, told me he entirely concurred, and in his work* he observes “The curvatures of the spine ensuing from

* “A Treatise on Diseases of the Bones,” by E. Stanley. London, 1849.

rickets, do not exhibit characteristic features, distinguishing them from the curvatures which arise under various other

FIG. 24.



Tilting of the pelvis in a case of general rachitic distortion; left leg two inches shorter than the right;—an extreme degree of lateral curvature of the spine produced by the obliquity of pelvis.

circumstances. He remarks, however, “The curvatures from rickets occur at an earlier period of life than the curvatures otherwise induced, which appear usually in females between the ages of ten and sixteen years.”

In the rachitic class of spinal curvatures the structural changes do not appear to be greater than in other cases, indeed I believe they are not so great, because, according to my observation, the rachitic curvatures take place at a later period than the cases essentially depending upon constitutional and

hereditary causes, which occur in infancy and early childhood. This opinion is confirmed by numerous specimens in the museums of London, in which the pelvis has been preserved together with the spine; and generally in these cases, even when the spinal distortion is of extreme severity, the pelvis may be seen to be well formed, and of full proportionate size, so that there could be no impediment to natural labour, and the rachitic origin is clearly negatived; whilst in those specimens of undoubted rachitic origin, and in which considerable pelvic deformity exists, the spinal distortion is certainly not more severe, and in some instances, is decidedly less.

Deformity of the Chest in Cases of Lateral Curvature of the Spine.

In all cases of lateral curvature of the spine in the dorsal region, we have as a necessary result of the series of adapted structural changes upon which this deformity depends, more or less distortion of the chest, varying in different cases according to the form of the curve, *i.e.*, whether single or double, long or short, and also according to the severity and duration of the curve. The chest deformity is most severe, 1st, in cases of *single curve* involving the entire dorsal region—*long single curves* they may be called for the purpose of description, though, as already stated, this involves anatomical inaccuracy. 2nd, in cases of *unequal double curve* in which the dorsal curvature largely predominates.

The chest deformity is often slight in cases of double curve in which the dorsal and lumbar curves are about equal in length, and therefore necessarily short, and pretty equally balance each other.

A slight deformity of the chest indicated by an undue prominence of one of the breasts, frequently exists before any lateral deviation of the apices of the spinous processes has taken place. In such cases, a slight projection of the right shoulder with some prominence of the scapula and of the angles of the ribs on the same side will also be found, and these deviations, when coexisting, certainly indicate that internal curvature of the spine has to some extent taken place.

External characters of the distorted chest. When the curve in the dorsal region is of moderate severity, the general appearance of the chest is that of increased prominence and enlargement, in its posterior and lateral aspects, on the side of the convexity; and depression, or sinking-in of the ribs on the side of the concavity of the curve. Supposing the convexity of the curve to be on the right side—its usual direction—the transverse diameter measured externally from the apices of the spinous processes to the axilla, crossing the angle of the scapula, would be from one to two inches greater than the corresponding line of measurement on the left side. The ribs on the right side will be found more horizontal in their direction, and more widely separated from each other than natural, whilst on the left they will be found more oblique and approximated to each other, so as to produce the appearance of sinking-in on this side. This may be seen in Plate II., although the case was one of only slight deformity. The capacity of the chest, therefore, appears to be increased on the right, and diminished on the left side, though such is not really the case. The left breast is more prominent than the right, and its nipple directed more towards the left side than natural.

When the curvature is *severe and of long standing*, these external characters are materially modified. The vertebral column is diminished in height, perhaps to the extent of one-third or even more, by the lateral flexion which in a later stage is superadded to rotation. The ribs on the side of the convexity are flattened in their lateral and anterior aspects, and project in an angular form posteriorly so as to cause a most unsightly prominence, which is increased by the obliquity of the scapula. In these severe cases the ribs are bent upon themselves a little in front of their angles, and flattened laterally, so that the capacity of the chest on this side is diminished to an extreme degree. On the side of the concavity the depression of the ribs is proportionately increased, the ribs being extremely oblique, and often in contact with each other at the lower and front part; the lower ribs frequently come in contact with the crest of the ilium, and dip into the pelvic cavity, producing

pain, which may prevent the patient from assuming the erect position, and therefore render either sitting or walking impossible.

Anteriorly the symmetrical form of the chest is completely destroyed, the sternum becomes very oblique, its lower extremity projecting, and the cartilages of the ribs corresponding to the side of the concavity of the curve—usually the left—are prominent and bent upon themselves; the oblique diameter of the chest therefore is increased, but the capacity of the chest is altogether materially diminished, causing considerable disturbance in the relative position of the heart and lungs, and giving rise to functional derangement of these organs.

Contrary to what might be expected from the external appearance, the capacity of the chest is diminished to the greatest extent on the side of the convexity of the curve, in consequence of the bodies of the vertebræ in their twisted direction projecting internally towards the sides of the ribs, the ribs themselves being flattened laterally, so that the latter may be almost in contact with the bodies of the vertebræ.

Although this change in the form of the chest is one which occurs naturally during the progress of the deformity, and exists to a greater or less extent in all cases, yet the effect of long continued and severe lateral pressure by the steel plate of a strong spinal instrument on the side of the convexity would be to increase the flattening of the ribs, and still further diminish the capacity of the chest. In Fig. 28, taken from a dried preparation in the museum of the College of Surgeons, this fact is well shown, the space between the bodies of the vertebræ and the internal surface of the ribs being only three-fourths of an inch, by actual measurement.

This specimen is an old one, and of a date long anterior to the invention of steel plates, so that it better illustrates the natural change in the capacity of the chest referred to.

At the post-mortem examination which I made of the case from which Figs. 38 and 39 were taken, I found there was only just room enough to pass the hand between the bodies of the

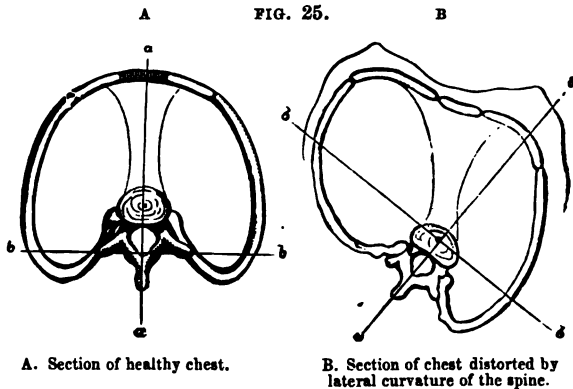
vertebræ, and the ribs—certainly not more than an inch—on the side of the convexity of the curve.

The Clavicles become altered in their direction in proportion to the deformity of the chest, but the deviations of these bones are of no importance, either in a diagnostic or practical point of view, though occasionally they may attract the notice of parents, and give rise to some anxiety.

Explanation of the peculiarities in the form of the distorted chest.—As the deformity of the chest essentially depends upon the deformity of the spine, it follows that the peculiarities of the spinal distortion also determine the peculiarities of the deformity of the chest. I have already shown that the distortion of the spine in lateral curvature, depends upon the double influence of horizontal rotation of the bodies of the vertebræ, and lateral flexion of a portion of the spinal column; the curved portion of the column presenting the appearance of a peculiar spiral twist, rather than a simple lateral flexion. There is no doubt that horizontal rotation of the bodies of the vertebræ *takes place as one of the first and most important of these changes*, associated with some alteration in the aspect of the oblique articulating processes, and that lateral flexion of the column occurs subsequently to the rotation movement. The external evidence and proof of this, is to be found in the deviations which take place in the form of the chest anteriorly and posteriorly, before any lateral deviation of the apices of the spinous processes occurs. An increased projection of the angles of the ribs posteriorly on the side of the convexity of the curve, giving rise to an increased prominence of the scapula on the side—usually the right—and an increased prominence of the breast on the opposite side, are the deviations in the form of the chest which first attract attention, and the following diagram copied from Sir C. Bell's Essays,* and originally made by Mr. Alexander Shaw, accurately illustrates the manner in which these changes are produced. Sir C. Bell observes, "Mr. Shaw has well explained, by these outlines, the effect of the upper twist, or revolution of the spine."

* "Practical Essays," by Sir Charles Bell. Edinburgh, 1842. Page 125.

“Suppose we present a horizontal section of the trunk thus; Fig. 25 A, what will be the effect of the twist which brings out the lateral processes of the vertebræ on the right side? It will be this; that whilst the angles of the ribs project behind on the right side, the left side of the chest, and consequently the left breast, will be made prominent on the fore-part, Fig. 25 B.”



“Upon the whole, then, the effect of the lateral or sigmoid distortion is to produce an ungainly walk, to curtail the girl of her natural stature, to disfigure the bust, or neck and shoulder, and to push out the left breast. But more, if permitted to increase (and it is of a nature to increase when once the bias is given) the capacity of the chest is diminished, and the lungs compressed, with consequent injury to the general health.”

The effects of horizontal rotation of the bodies of the vertebræ in the dorsal region, in distorting the form of the chest, are accurately represented in the above diagram, and if to these changes we add the effects of lateral flexion of the spinal column, the more essential deviations in the form of the chest are easily and satisfactorily explained. One alteration, however, seen in the more advanced cases, appears to be more difficult of explanation, viz. :—the lateral flattening of the ribs on the side of the convexity of the curve. Some authors consider this to depend upon a rachitic softening of the ribs, and upon this

evidence alone I have known such cases pronounced to be of a rachitic nature. Careful observation in a large number of cases will soon correct this fallacy, but to give a satisfactory explanation is more difficult. Possibly it may depend upon muscular action exerted to preserve the general equilibrium of the body, and to maintain the thoracic and abdominal cavities in their normal relation to the spine and pelvis.

Distortion of the Pelvis in Cases of Lateral Curvature of the Spine.

It may now be considered as an established fact that deformity of the pelvis occurs only in one class of cases of lateral curvature of the spine, viz:—those of rachitic origin, and in which the evidence of general rachitis is unmistakably present.

In all other cases of lateral curvature of the spine, the pelvis is of its full natural size, and well-formed; hence we find that, with the exception of the rachitic cases, women with

FIG. 26



Deformity of pelvis in severe case of rickets.

severe spinal curvature do not suffer during labour from any want of space in the outlet of the pelvis, and it has even been remarked by experienced accoucheurs that they generally have easy labours. The existence of pelvic deformity in cases of rickets, and its absence in other cases, are well shown in

numerous skeletons, and dried preparations of the spine with the pelvis attached, preserved in the museums of London.

In all cases of rickets, the pelvis in the adult, is below its natural size, and this alone may interfere with natural labour. But with rare exceptions, distortion is also super-added to arrest of growth; so that the passage of the child through the pelvic cavity is impossible, and therefore in such cases the Cæsarian operation must be performed, as it was in the woman whose pelvis is represented in Fig. 26, unless the child be destroyed at an early period.

The drawing from this specimen was made by permission of the late Mr. Carr Jackson. The case had been operated upon by Dr. H. H. Broughton, of Preston, who performed the Cæsarian operation, all attempts to procure abortion having failed. The woman was thirty-seven years of age, and had had two previous abortions. She was deformed, and the spine was distorted to an extreme degree. The contraction of the pelvis was so great, that a wooden ball of $1\frac{1}{4}$ inches in diameter would only just pass through it. In this specimen the bones were light but hard in texture, as in the rachitic deformities met with in the adult.

It is unnecessary to describe the peculiarities of the rachitic deformity of the pelvis which are well exhibited in Fig. 26. I would merely mention that its leading features are, 1st—flattening from above downwards, produced by the yielding of its softened bones to the superincumbent weight; this causes the promontory of the sacrum to be approximated to the symphysis pubis, and the antero-posterior diameter to be proportionably diminished. 2ndly—A bending inwards of the pubic bones, in consequence of the resistance offered below by the heads of the thigh bones; this still further diminishes the antero-posterior diameter, and the transverse diameter is proportionably widened; the oblique diameter is diminished in proportion to both these deviations. The alæ of the pelvic bones are bent forwards, or folded upon themselves in severe cases, such as that from which Fig. 26 was taken, although the latter condition is generally more observable in cases of pelvic deformity from *mollities ossium* in which the

pelvis has attained its full size previous to the occurrence of the disease. *Mollities ossium* is invariably a disease of adult life, whilst rickets is essentially a disease of infantile life; therefore in a specimen of distortion, however severe, from *mollities ossium*, the pelvis, if it could be unfolded, as it were, and the distortion removed, would be seen to be of its full proportions; but in a specimen of rachitic distortion, if the pelvis could be unfolded and the distortion removed, it would be seen to be much less than its natural size in consequence of the arrest of growth, which is one of the characteristic features of rickets.

It is important to bear in mind the general characters by which the rachitic form of lateral curvature may be recognised, since it is only in this class of cases that we can infer the existence of pelvic distortion.

Obliquity of the Pelvis in Cases of Lateral Curvature of the Spine.

Obliquity of the pelvis is supposed to exist much more frequently in cases of lateral curvature than it really does, and the deceptive condition which most frequently leads to this supposition is, a prominence, or, as it is called, "a growing out" of one hip, such as I have shown to depend upon curvature of the spine in the lumbar region, represented in Fig. 17. The prominence of the hip is caused in these cases by the receding of the muscles in the concavity of the lumbar curve, and though frequently attracting attention and causing anxiety, when the spinal curvature is not known to exist, it is really of no importance except as a diagnostic indication of the spinal curvature, and generally does not depend upon any tilting of the pelvis.

In long standing cases of severe lumbar curvature, the general balance of the body, in the erect position, is in part maintained by habitual tilting of the pelvis, and these patients therefore walk with a twisting movement of the body. In some of the anatomical specimens in which the pelvis has been preserved in its natural connections with the distorted spine, some obliquity of the sacrum and coccyx may be seen to

contribute, together with the lower lumbar vertebræ, to form the curvature. When patients in this condition are examined, the pelvis can always be brought into its normal relation with the legs, so that the anterior superior spinous processes are found to be the same height from the ground, but still the general balance of the body will be disturbed, and the head deviate from the central line. The permanent obliquity of the pelvis in these cases is always slight, and produced as a late effect of the curvature in the effort to maintain the equilibrium of the body.

Obliquity of the pelvis necessarily exists in all cases of irregularity in the length of the legs, when the condition is of long standing, such as we see in severe rachitic deformity, in which one leg is frequently much more deformed and shorter than the other. This condition is well exhibited in Fig. 24, taken from a skeleton, greatly distorted by rickets, in the museum of the Royal College of Surgeons, No. 2879 B. In this skeleton the left leg is much more deformed than the right, principally by severe curvature of the tibia and fibula, and is also two inches shorter; hence the extreme degree of obliquity of the pelvis and the consecutive curvature of the spine produced by this obliquity. The pelvis itself is less deformed than that shown in Fig. 26, but is smaller than natural in all its dimensions, and is distorted in a somewhat similar manner.

Obliquity of the pelvis to an extreme degree constantly follows in cases of congenital dislocation of the femur at one hip-joint, which at the age of twenty may cause shortening of the leg to the extent of four inches, an example of which occurred in a young lady under my care. In this case, although a raised boot was worn, and a spinal support used for several years, it was impossible to prevent the formation of a certain amount of spinal curvature. In such a case, some general distortion of the pelvis in an oblique direction is also sure to occur. When dislocation exists at both hip-joints; tilting of the pelvis forwards and *lordosis* of the spine takes place, as already described and shown in Fig. 9. Many other conditions of the lower extremities, such as

dislocation or ankylosis of the femur in a flexed position, contraction of the knee-joint, &c., producing irregularity in the length of the legs will also certainly cause obliquity of the pelvis, and produce spinal curvature as represented in Fig. 27.

If the horizontal line *a b*, representing the pelvis, is rendered

FIG. 27.

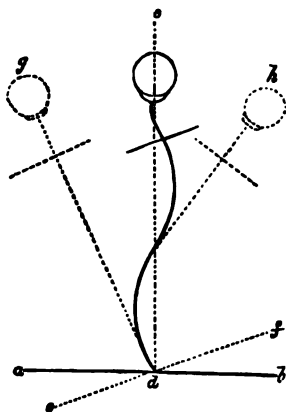


Diagram illustrating the production of lateral curvature caused by obliquity of the pelvis.

oblique from any cause, and assumes the direction of the oblique line *e f*, the perpendicular line *c d*, representing the spinal column, must be inclined laterally to a corresponding extent; but in order to maintain the equilibrium of the body and bring the head into its natural position directly over the centre of the base of support, the spinal column must again bend upon itself, and thus a double lateral curvature is necessarily produced as a mechanical compensation.

Obliquity of the pelvis with slight spinal curvature may be simulated, or it would perhaps be more correct

to say may exist, as a temporary condition in some cases of hysteria. Of this I had a good example in a girl aged 17, under my care in the Orthopædic Hospital, who, when admitted, was totally unable to sit or stand, and had been in this condition for nine months. The pelvis was tilted laterally to an extreme degree, the right crest of the ilium being drawn upwards, and consequently the right leg appeared to be three or four inches shorter than the left. This girl attributed her illness to a fall down a cellar, but I could discover no trace of injury or disease; she was extremely hysterical, and I regarded the case as one of hysterical contraction of the spinal muscles on the right side, and also of the abdominal muscles in the right lumbar region. Under chloroform there was no difficulty in restoring the pelvis to its natural position. This

girl had been actively treated in a hospital by counter-irritation, &c., but during the period she remained under my care, no other treatment was adopted than the application of a strong spinal support. This soon enabled her to sit upright, and by degrees to stand, but the tilting of the pelvis remained, and the right leg appeared about four inches shorter than the left; this, however, gradually diminished, the right foot came to the ground; the tilting of the pelvis disappeared, and before leaving the hospital she walked very well.

Other cases of less severity have frequently come under my notice, in which irregularity in the length of the legs and tilting of the pelvis have existed, as a temporary condition, generally in young ladies suffering from hysteria.

Condition of the Ligaments and Muscles in Lateral Curvature.

Having now described the various structural changes affecting the spinal column, the chest, and pelvis, in cases of lateral curvature of the spine, let us proceed to examine the state of the soft parts connected with the spinal column, viz., its *ligaments and muscles*, to which the highest degree of importance is generally, but I believe erroneously, attached in reference to the production of lateral curvature. First with respect to

THE LIGAMENTS. In most books on spinal curvature you will find it stated that *the ligaments are elongated on the convex, and contracted on the concave side of the curvature*. I have already explained at some length (see Lect. II.), that there are no distinct ligaments placed laterally along the bodies of the vertebræ which could be subject to the contraction and elongation alleged; while at the same time the anatomical and physiological errors involved in the theory of lateral curvature, based on the assumed condition of ligaments, have been sufficiently pointed out.

In all cases of lateral curvature there can be no doubt that such ligaments, or ligamentous bands, as may become involved, readily adapt themselves to the altered relations of the bones,

as a part of the series of adapted structural changes, affecting the oblique articulating processes and the intervertebral cartilages, which take place from the moment a curvature of the spine is established.

In cases of weak spines, many of which are often assumed to be cases of lateral curvature, and treated as such, general muscular and ligamentous debility and relaxation undoubtedly exist, and they may pass into true lateral curvature; but it is certain that a large proportion of cases of lateral curvature of the spine are not preceded by, or accompanied with this state of general debility, and that on the other hand, such debility frequently exists without passing into lateral curvature of the spine.

MUSCLES. There can be no reason to suspect the existence of any structural changes in the spinal muscles in cases of lateral curvature of the spine when recent, except in those rare instances in which the curvature depends upon partial or complete paralysis of some of these muscles, which would in such cases probably be found passing into a state of fatty degeneration.

In all the dissections I have had the opportunity of making at late periods, *i.e.*, cases of severe spinal curvature in the adult, the muscles on both sides of the spine have been much wasted, reduced in several instances to very thin layers, pale in colour, and in more or less advanced stages of fatty degeneration, which probably commences in the muscles in the concavity of the curve, those on the convexity wasting at a much later period.

As opportunities occur of making these examinations at different periods of life, it would be important to investigate the exact state of the muscles individually, since a knowledge of their structural conditions would probably assist in determining the accuracy of the important theory advanced by M. Guérin as to the mode of production of this deformity, *viz.*, that it depends essentially upon active muscular retraction of some of the spinal muscles. M. Guérin states that active retraction of a muscle gives rise to fibrous degeneration, and the

passive retraction to fatty degeneration. In other non-congenital deformities, such as talipes equinus for example, we have permanent muscular shortening, in two very distinct classes of cases, viz. : the paralytic and the spasmodic.

From the microscopical examinations I have made, in several cases, of the retracted muscles under these different conditions—an account of which is published with illustrations in Vol. III. of the Transactions of the Pathological Society—it appears that in paralytic affections of long standing the muscular structure undergoes complete atrophy and fatty degeneration; whilst in spasmodic affections the muscular structure undergoes little or no alteration, though the affection may have existed for many years. The nutrition of the muscles in the latter class of cases appears to be maintained sufficiently to prevent degeneration of structure; I doubt, therefore, the tendency to fibrous degeneration in the retracted muscles as described by M. Guérin.

The condition of the muscles in these two classes of cases during life is very different. In paralytic affections of long standing, the retracted muscles are flaccid, diminished in bulk, and atrophied to an extreme degree, so that their outline cannot be distinctly recognised by external examination. In spasmodic affections, even when of long standing, the retracted muscles are rigid, prominent, and well defined, though somewhat smaller than those of a healthy individual of the same age, apparently from defective growth, rather than degeneration of existing tissue.

In cases of spinal curvature we have certainly, during life, some indications of the existence of similar muscular conditions, viz., the paralytic and flaccid, and the spasmodic and rigid; but there can be little doubt that the prominence and rigidity of certain muscles frequently seen in cases of spinal curvature, are dependent upon other causes than muscular spasm.

The prominence and rigidity of the spinal muscles in the lumbar region, frequently seen on the convexity of a sharp lumbar curve, often conveys to the touch a doubtful sense of fluctuation, and has frequently led to a suspicion of abscess, as

in the case represented in Plates III., IV. and V.; but in such cases the prominence is undoubtedly due to the muscles being pushed out by the transverse processes of the vertebræ, which project towards the skin on the convexity of the curve, in consequence of the horizontal-rotation movement of the bodies of the vertebræ; and partly also to these muscles being put on the stretch, as they must necessarily be from their situation on the convexity of the curve, and the effort they are called upon to make in the attempt to preserve the equilibrium of the spinal column.

It should be particularly observed, that the muscles in the concavity of the curve, which from their situation would be those to *draw the spine into a curved direction*, if curvature, indeed, is ever produced by active muscular contraction, are never found to be either prominent or rigid.

The same explanation will also apply to the prominence of the muscles on the convexity of the curve in the middle dorsal region, between the spinous processes and the posterior border of the scapula, where they are pushed out by the angles of the ribs, as well as by the transverse processes. The prominence of the anterior and upper portion of the trapezius, which has sometimes been mistaken for fatty or cystic tumour, or even for abscess, also depends upon a similar condition of the upper dorsal and lower cervical vertebræ, when a sharp curve exists in this region.

Although, therefore, some similarity may be traced in the external appearance of the prominent and tense muscles met with in some cases of lateral curvature of the spine, and the rigid and prominent muscles of the extremities in spasmodic deformities, and this may by some authorities be adduced in support of a theory of similarity in causation, a more careful examination will show that these appearances are produced by very different causes, and indicate very different pathological conditions.

Some deviations in position and direction of the spinal muscles have been already adverted to, respecting their prominence in different regions. Other deviations frequently exist, but with

two exceptions, need not be described. It is stated by many authorities that in severe cases of curvature in the lumbar region, the spinal muscles on the convexity of the curve not only become prominent and tense, but overhang the apices of the spinous processes to such an extent, that their line of action becomes altered, and like the string of the bow, they act in the concavity of the curve, and tend constantly to increase the lateral flexion of the spine. Frequently as this observation is to be found in books, I believe it to be incorrect. There can be no doubt that the muscles on the convexity of a lumbar curve frequently overhang the apices of the spinous processes, but I have never seen this to an extent sufficient to alter the line of action of these muscles from the convex to the concave side of the curve. Moreover, apart from the anatomical question, I believe that the continued prominence and tension of these muscles show that they are still exerting their influence on the convex side of the curve, to prevent increase of curvature.

As another change in the muscular relations observed in cases of lateral curvature, I would allude to that of the latissimus dorsi, from beneath the upper border of which the angle of the scapula frequently escapes, and then projects prominently backwards. The effect is to render the deformity more conspicuous, but practically it is of no importance.

Let us now consider to what extent the spinal cord and nerves are affected in lateral curvature.

Influence of Lateral Curvature upon the Spinal Cord and Nerves.

The spinal cord does not appear to suffer compression, even in the most severe cases of lateral curvature, and this obviously depends upon the fact that the spinal canal is not encroached upon, or diminished in size by the curvature of the spine. It is remarked in Sir Charles Bell's* "*Practical Essays*," note 6, by Mr. A. Shaw, that as the cord necessarily follows the spiral twist of the vertebral column, it must suffer in some degree from pressure and absorption where bent or twisted

* *Op. cit.*

upon itself, and that possibly this might explain some of the symptoms such as pain, spasm, or partial paralysis.

The *spinal nerves* in consequence of the large size of the foramina through which they pass are not liable to suffer compression, except perhaps in some cases of extreme severity; and Mr. Shaw observes that in some of these cases the nerves and the ganglia belonging to the sensitive roots, lodged in the foramina, may occasionally be compressed, though he has not verified this by dissection, nor have I satisfactorily traced this result in the post-mortem examinations I have made.

Influence of Lateral Curvature in Causing Displacement of the Thoracic Viscera.

In severe cases of lateral curvature the chest is divided into two cavities of very unequal size and irregularity of form, by the deviations of the bodies of the vertebræ and the alterations in the form of the ribs, as represented in the diagram, Fig. 34 B; therefore as the anterior and posterior mediastina preserve their attachments (the posterior mediastinum following, as a general rule, the curve of the vertebræ, and the anterior the oblique direction of the sternum), the contained viscera must be both altered in their relative position and compressed.

The thoracic cavity on the side of the convexity of the curve is flattened and diminished in size to a much greater extent than that on the concavity, in consequence of the flattening of the ribs on the convexity of the curve, and also because the bodies of the vertebræ are twisted laterally towards the flattened ribs, which they frequently approach within one or two inches, and are occasionally brought almost in contact with them. At the post-mortem examination of the case represented in Fig. 38, I could only just pass my hand sideways between the bodies of the vertebræ and the ribs. A similar condition is well exhibited in Fig. 28, copied from a dried preparation in the museum of the Royal College of Surgeons. In this specimen, the cavity of the chest on the right side, between the bodies of the vertebræ and the ribs, was reduced to three-quarters of an inch.

The lung on the convexity of the curve, therefore, is always much compressed and flattened, and gradually becomes diminished in size; its expansion during respiration is prevented by the diminution in the capacity of this side of the chest, and by the limited play of the ribs consequent upon their deviation in form and direction, and the atrophied condition of the muscles. Increased action is therefore thrown upon the lung in the concavity of the curve.

The thoracic cavity on the side of the concavity of the curve is always found to be much larger than would be expected from the external form of the chest, and the sinking-in of the ribs on this side. This is explained by the fact that the bodies of the vertebræ are always twisted towards the convexity, often at an angle of 45° or even greater; so that on the side of the concavity an irregular, wide, and somewhat vaulted chamber exists, into which the posterior mediastinum bulges, and allows the lung of the opposite side to encroach more or less upon its space. The diaphragm also rises high in the concavity of the curve, pushed upwards by the liver, which is much displaced, and encroaches on the thoracic cavity. This existed to a remarkable extent in the case Fig. 38.

The lung on the concavity of the curve may be somewhat altered in form, but is not diminished in bulk like the lung on the side of the convexity. From the increased duty thrown upon this lung, there may exist an increased liability to disease.

The heart is generally displaced towards the concavity of the curve, and Bouvier states that this is the case even when the convexity of the spinal curve is towards the left side. In the case shown in Fig. 38, in which a large curve to the left side existed, involving the whole of the dorsal and the upper lumbar vertebræ, the ribs were extremely flattened, the heart was displaced a little towards the right side, and was situated in the concavity of the curve, as Bouvier states it generally is. In this case the heart was very small, pale, and wasted, but the patient had been paralysed in both legs from infancy. When I first saw her in 1852 she was thirty-nine years of age,

and had not walked for twenty-two years. Bouvier states that the heart is sometimes found enlarged and dilated, or hypertrophied.

The aorta both in the thoracic and abdominal regions is said generally to follow the curves of the spine, and to be retained in its normal relations to the vertebræ by the intercostal and lumbar arteries. This is shown to be the case in a dried specimen of curvature of the spine, with the aorta injected, preserved in the museum of the Royal College of Surgeons, and represented in Fig. 28, and a similar specimen is described as existing in Sandifort's museum.

FIG. 28.

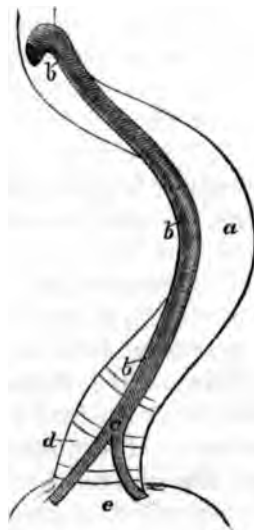


Part of a spine with lateral curvature to right side, through the whole dorsal region—Aorta curved and tortuous, preserving its natural relations to vertebral column—Space on right side of chest between bodies of vertebræ and ribs reduced to three-quarters of an inch.

But, at the post-mortem examination, made by my friend, Dr. Allen, of St. John's Wood, and myself, of the case shown in Fig. 38, in which the whole of the dorsal and the upper lumbar vertebræ were involved in a large curvature to the left side, the aorta was displaced to the right side of the vertebræ through the lower dorsal and upper lumbar regions, where it passed like the string of a bow (to use a favourite but somewhat

exaggerated expression) across the concavity of the curve, as represented in Fig. 29. The displacement of the aorta *b b*, appeared to have been caused very much by the displacement of the diaphragm, which was drawn remarkably to the right side, and its costal attachments descended obliquely into the right pelvic cavity in consequence of the extreme obliquity of the ribs on this side.

FIG. 29.



Sketch of spinal column with lateral curvature of left side, *a* through the whole dorsal and part of lumbar regions—Aorta *b b*, displaced to right side of vertebral column in lower dorsal region—Bodies of vertebrae on convexity of curve were, as in Fig. 28, nearly in contact with the ribs—*c*, Bifurcation of aorta—*d*, fifth lumbar vertebra—*e*, pelvic cavity. From case shown in Fig. 28.

The œsophagus is said by Bouvier to deviate very little, or not all, from its straight position, and he describes it as forming, opposite the centre of the curvature in the dorsal region, the string of the bow which the artery represents as it follows the convexity of the curve. In the post-mortem examination above referred to, the œsophagus did not appear to deviate materially from its straight direction.

Influence of Lateral Curvature in Causing Displacement of the Abdominal Viscera.

The abdominal viscera, in consequence of their greater mobility, and the yielding nature of the abdominal parietes, are less likely to suffer from displacement and compression, even in cases of severe lumbar curvature, than the thoracic organs; yet, we frequently see patients with severe lateral curvature—especially in cases of single curve in which the whole of the dorsal and the upper lumbar vertebræ are involved (as shown in Fig. 32)—who suffer from functional derangement of the liver and stomach, to an extent which seriously interferes with the general health.

The liver, of all the organs, is that which presents the most varied alterations in form, in consequence of its large size, soft texture, and its relations with the lower ribs, by which it is more especially exposed to pressure; and also because during growth, while spinal curvature is slowly, but progressively increasing, the liver gradually accommodates itself to the altered form and relations of the thoracic and abdominal cavities. Even when women have long been in the habit of tight lacing we see this power of adaptation altering materially the form of the organ, the surface of which exhibits oblique lines of indentation corresponding in direction and size to the ribs, by the pressure of which, they have doubtless been made; such mis-shapen and indented livers I have frequently seen during the time I made the post-mortem examinations at St. Thomas' Hospital.

In cases of severe spinal curvature the liver becomes much displaced, and altered in form, varying of course according to the direction and extent of the spinal distortion. In the post-mortem examination of the case above referred to, of severe curvature to the left side, Fig. 38, the liver was seen to be not only much altered in form, being elongated and indented, but so displaced as to encroach considerably upon the

right side of the thoracic cavity; the diaphragm was therefore pushed upwards and ascended as high as the upper border of the third rib, the lung descending behind the liver. The tissue of the liver in this case, was in a state of fatty degeneration, though not far advanced; and the gall-bladder contained six gall-stones of rather large size. Possibly some of the seven spasmodic attacks—spasms of the diaphragm they were said to be—from which this lady suffered, were due to the passage of gall-stones.

Mr. J. Shaw mentions the case of a young lady, who suffered severely in consequence of the pressure of the ribs on the liver.*

The kidneys, although necessarily much displaced in severe cases of spinal distortion, do not appear often to suffer from pressure, but Mr. J. Shaw refers to a case recorded by Portal in which, from the pressure of the ribs upon one of the kidneys, the secretion and flow of urine were effected.

The spleen is more likely in some cases to suffer from compression, but I have not been able to trace by dissection any deviation in this organ. Several cases have fallen under my observation, in which the patients have been said to suffer from enlargement of the spleen, and there certainly has appeared to be a prominence of this organ which has, however, yielded to medical treatment.

The aorta has been already described as generally retaining its normal relations with the spinal column (see Fig 28), but it is occasionally displaced to the right side, passing along the concavity of a curve when a severe lateral curvature, with its convexity to the left, exists in the dorsal region, see Fig. 29. *The inferior vena-cava and vena azygos* are said, also, generally to describe the same curvature as the spinal column, with which they retain their normal relations, but when deviation of the aorta exists, these vessels probably also deviate in their course in a similar manner.

The stomach and intestines, by their natural mobility, escape the injurious effects of pressure, but are much displaced

* *Op. cit.*, page 260.

in severe cases of spinal distortion, the stomach especially, deviating in its position when the curvature occupies the lower dorsal and upper lumbar regions.

This concludes the observations I have to make on the morbid anatomy of lateral curvature of the spine, and in the next Lecture we will proceed to the general pathology of this affection.

LECTURE VI.

GENERAL PATHOLOGY OF LATERAL CURVATURE OF THE SPINE.

—ETIOLOGY AND MODE OF PRODUCTION.

I know of no affection, the treatment of which should be more directly influenced by a consideration of the causes which produce it, than lateral curvature of the spine, and therefore we cannot too closely analyze the precise nature and *modus operandi* of the various causes which are said to produce this form of spinal curvature. Generally in books on lateral curvature we find the causes traced either to certain conditions of the muscular system, or to certain occupations associated with these conditions; thus in one of these works, we find the causes arranged under the several heads of: 1st, muscular and ligamentous debility; 2nd, muscular hypertrophy; 3rd, muscular atrophy; and 4th, spasm of the muscles, and though other influences, such as obliquity of the pelvis, rickets, and some organic affections are admitted as causes, the cases are generally assigned to the muscular conditions above adverted to. In another book we find only one class of cases described, viz: those depending upon muscular debility, the other forms of this affection being merely enumerated. We cannot, therefore, be surprised to find only one method of treatment, such as a spinal instrument of the author's invention, recommended for all cases. Now, it appears to me, that a careful study of this affection must necessarily lead to the conviction that lateral

curvature of the spine depends very greatly upon certain *constitutional conditions*, such as a *hereditary tendency* to this affection, which may be traced probably in half the cases which come under our notice; a *strumous diathesis* associated with which, the worst forms of curvature, often erroneously classed as cases of rickets, are frequently seen; and *constitutional debility* either existing from infancy or induced by febrile affections, &c.

Coexisting with these constitutional conditions we can also in most instances, in which the spinal curvature is produced after ten or twelve years of age, but not in those of an earlier date, trace certain *local causes* acting mechanically so as to disturb the equilibrium of the spinal column; and upon a careful consideration of the relative causative influence of these constitutional and local causes, in any given case, I believe it is alone possible to determine the principles of treatment applicable to such a case.

The causes of lateral curvature may be arranged in two classes, viz., the predisposing, and the proximate causes.

1st. *Predisposing causes.* These are essentially constitutional, either hereditary or acquired, such as hereditary predisposition; strumous diathesis; constitutional debility; rickets; induced or temporary muscular debility.

2nd. *Proximate causes.* These are essentially local, and act mechanically upon the spinal column, disturbing its equilibrium, such as: *a.* the long continuance of certain bad positions, such as the habit of standing on one leg; the sitting position during education, especially for writing and drawing purposes; sitting cross-legged and in a stooping position, as some young ladies do for several hours a day when fond of reading; excessive horse exercise, to which delicate girls are frequently subjected with the object of improving the general health, but often with the result of producing a curvature of the spine with rotation in the lumbar region; *b.* certain occupations, such as needlework, envelope and book-folding, flower-making, &c.; also nursing children, or carrying weights; ironing, and any other occupation which may render necessary

the long continuance of any position which would disturb the equilibrium of the spinal column ; *c.* inequality in the length of the legs from any cause; the use of a wooden leg, &c.; and *d.* certain diseases of the chest, such as empyema, and some other affections of the thoracic and abdominal organs.

The *modus operandi* of all these proximate causes is the same, the resulting curvature of the spine being produced by the *long continued irregular distribution of weight*, resulting from any position which, for a sufficient length of time, disturbs the equilibrium of the spinal column, and throws the weight continuously in one direction.

The immediate cause, therefore, in all cases is mechanical, and I have already demonstrated in the preceding lectures that the structural changes produced, are merely the effects of mechanical pressure.

In explaining the origin and mode of production of any case of lateral curvature, we must first endeavour to ascertain the existence of any of the predisposing causes, and then recognise the purely mechanical cause, *i.e.*, the irregular distribution of weight, as immediately and directly producing the structural changes which render the curvature fixed, persistent, or confirmed as it is frequently called; it being considered as proved that no persistent curvature, however slight, can exist unaccompanied by such structural changes.

Let me now direct your attention to the principal theories, more or less in vogue at the present time, as to the mode of production of lateral curvature, and first

The Muscular Theory of the Production of Lateral Curvature.

A question of great practical importance is involved in the consideration of this theory, *viz.*, whether we ought, or ought not, to include amongst the direct and immediate causes of lateral curvature certain conditions of the muscular system such as irregular muscular action, excessive use of one arm, the increased development of certain muscles produced by carrying heavy weights, and in certain occupations, paralytic and

spasmodic conditions of certain muscles, &c. Different views will no doubt be taken of this subject, but after careful consideration I have determined to exclude all such conditions from the direct and immediate causes of lateral curvature. There can be no doubt that in many cases of lateral curvature some of the muscular conditions described do exist, but it must also be admitted that certain positions favourable to the production of curvature of the spine are concurrently assumed, and I have been unable to convince myself that the spine is *actively drawn* into these positions by the muscles.

According to the physiological views which I have explained in the second lecture, I see no necessity for inferring the existence of this active muscular contraction in the production of spinal curvature ; and in the examination of a large number of cases I have been unable to detect any evidence of its existence. The muscles in the concavity of the curve in a case of recent curvature, whether in the lumbar or dorsal region, are always soft and flaccid, evidently passing into a condition of atrophy which becomes more confirmed in proportion to the severity and duration of the curvature, whilst the muscles on the convexity of the curve are always seen to be tense and prominent. This is the reverse of what occurs in deformities connected with the movable articulations of the extremities, such as the knee and foot, when they depend upon active muscular or spasmodic contraction, the muscles in these cases situated in the concavities of the curves being always tense and prominent.

It has appeared to me that in the early stage of lateral curvature, the spinal muscles on both sides are, as a general rule, decidedly passive ; but that as the curvature advances, the muscles situated on the convexity of the curve are called into increased action, and being put on the stretch are always found, when the patient is in the erect position, in a state of tonic contraction, which serves the purpose of limiting the extent and preventing the increase of spinal curvature. The same opinion has been expressed by Mr. Bishop, to whose researches on this subject I have previously adverted. The muscles on the convexity of the curve, therefore, according to this view,

are beneficially exerting such power as they possess in opposing the flexion of the spinal column.

It will doubtless be argued by some, that *the position of the individual* is necessarily assumed as the result of certain muscles being called into undue activity—a disturbed balance of muscular action—and that, after all, the curvature is caused by muscular action; but of this I am unable to discover any direct or positive evidence.

As a practical answer to the objection that the positions by which the equilibrium of the spinal column is disturbed, are necessarily produced by muscular action, I would refer to such examples of lateral curvature as evidently cannot result from this cause and yet depend upon position, such for example as a child from one to three years of age said to have a *weak spine* and always nursed on one arm (such a case is represented in Fig. 11). It is not uncommon to see children of this age unable, from want of sufficient muscular power, to walk or sit up like other children, though they may be fat and apparently well nourished, and if such children should be nursed always on one arm, lateral curvature of the spine is sure to result. Independently of such one-sided nursing the spine presents only the appearance of general weakness, projecting posteriorly and curving in its entire length. When lateral curvature forms in these cases, it is clearly due to the constant tilting of the pelvis in the same direction whilst the child is being carried—a purely mechanical condition—combined with one of the recognised predisposing causes.

Lateral curvature of the spine consequent upon wry-neck, caused by contraction of the sterno-mastoid muscle, has been admitted as an example of curvature of the spine depending upon muscular contraction, by surgeons who oppose as strongly as I have done, the general applicability of the spasmodic muscular theory of M. Guérin and the muscular theory of the production of lateral curvature, as well as the practice arising out of it, viz., division of the spinal muscles;* but this example

* See a paper by Professor Syme, of Edinburgh, on this subject in the third volume of the "London and Edinburgh Monthly Journal," April, 1843.

certainly cannot be claimed as a favourable illustration of M. Guérin's theory. The primary and essential part of this deformity, we know, consists in the drawing downwards of the head by the sterno-mastoid muscle, the centre of motion being at the movable ball-and-socket articulation between the head and the spine. The spinal curvature is only a late effect of this deformity after it has existed a considerable time, and when the sterno-mastoid muscle though shortened, does not exhibit any appearance of active or spasmodic contraction.

It would be more correct, according to the classification I have adopted, to consider wry-neck as a predisposing, rather than an immediate or proximate cause of the spinal curvature. M. Guérin, the able advocate of the muscular theory, has long maintained that lateral curvature of the spine depends primarily and essentially upon muscular retraction, of an active character caused by some abnormal condition of the nerve centres.*

M. Guérin especially supports his theory by reference to cases of lateral curvature associated with cerebral and cerebro-spinal affections, generally coexisting with other articular deformities, such as club-foot, contraction of knees, hips, hands, elbows, &c., and sometimes also with wry-neck, or strabismus. He supposes the spasmodic or active muscular retraction to commence in the spinal muscles simultaneously with those of the extremities, or other parts, but to be less obvious in them from their being bound down by the strong fascia and aponeurotic structures on either side of the spine, which prevent the contracted spinal muscles appearing in prominent relief under the skin, like the sterno-mastoid in wry-neck, &c. The slow development of the spinal curvature in these cases he explains by reference to this peculiarity in the situation of the muscles, together with the greater resistance offered by the spine. Examples of spinal curvature occurring in monstrosities are also adduced in illustration of his theory.

Where the evidences of central nervous lesions are less

* "Mémoire sur l'Étiologie générale des Déviations latérales de l'Épine par rétraction musculaire active." Par Dr. Jules Guérin, Paris, 1840.

distinctly marked, and where no direct evidence exists, active muscular retraction is still traced as the essential cause of lateral curvature.

In the first class of cases are placed those he supposes to result from infantile convulsions, and which exhibit, in after life, either some slight spasmodic affection, such as strabismus, &c., or some defect of symmetry, as for example, cases in which the two halves of the face are not symmetrical; the features may be drawn to one side, the two halves of the forehead may be unequal, and other defects of symmetry may exist. In those cases in which no direct evidence of cerebral or cerebro-spinal lesions can be traced, the difficulty of the subject is admitted, but endeavoured to be overcome by tracing the similarity in several respects, such as the seat, direction, and number of curves existing between these cases, and those supposed to be of the more distinct form first described.

In explanation of some of the phenomena, it is also stated, that active retraction may be limited to one muscle, or part of a muscle, and paralysis may be limited in the same degree. M. Guérin states that he has seen "certain portions only of the trapezius retracted and fibrous, other portions being paralytic, atrophied and membranous, where the other muscles of the same side were healthy." Also that he has seen "cases in which the longissimus dorsi only was retracted on the side on which the sacro-lumbalis alone was passively shortened—others in which a single portion of these muscles, only a single fasciculus of the longissimus dorsi, for example, contrasted by its extreme tension and hardness with the normal consistence of the neighbouring parts."

That M. Guérin considers this theory to apply to the production of the ordinary form of lateral curvature when slight, and occurring in delicate and growing girls, is proved by the following circumstance.

A patient of mine, a young Russian lady, aged 15, who had a slight spinal curvature, represented in Fig. 30, was taken to Paris by her mother to consult M. Guérin, in September, 1852. He gave a written opinion of the case, in which the active

muscular retraction is described as the cause, and his usual treatment of division of the spinal muscles recommended.

FIG. 30.



Case of very slight double lateral curvature, for the cure of which division of the spinal muscles was proposed.

With regard to the prospect of benefit from mechanical treatment in this case, the amount of deformity which is shown by a cast represented in the above drawing, M. Guérin observed:—"Je n'hésite pas à déclarer qu'un traitement mécanique seul, quelque assidu quelque précis qu'il puisse être, est tout à fait incapable de produire la guérison de Mlle. C. Je doute même qu'il puisse produire quelque amélioration de la difformité." M. Guérin's recommendation that the spinal muscles should be divided in this case was not however submitted to, and the young lady was brought to England and placed under my care. She wore an instrument for nine months, every attention being at the same time paid to the general health, and returned to Russia in June, 1853, wearing stays stiffened by steel supports.

The spine at this period appeared to be quite straight, and it is satisfactory to be enabled to state that it has remained so up to the present time. In the year 1860 this lady again visited England and came to see me. I examined her carefully, and can confidently state that I never saw a straighter spine or a more symmetrical figure.

I have especially described the muscular theory of the production of lateral curvature, because it is the theory which has always been, and is at the present time, most generally received by the profession, and which has also gained the most favourable acceptance with the public, who, in their ignorance of the anatomical and physiological peculiarities of the spinal column, erroneously imagine that the muscles alone can produce either the flexion of the column in the ordinary movements of the body, or the curvatures which constitute deformity. In connection with this portion of our subject I have given M. Guérin's views somewhat in detail, not only in consequence of the value which must attach to any opinion expressed by its distinguished author, and the importance of the doctrine itself, as well as the practice arising out of it, viz., division of the spinal muscles, but also because M. Guérin still advocates it after many years' experience.

The late Mr. Tamplin was induced at one time to make trial of the practice recommended by M. Guérin of dividing the spinal muscles, but the result was not such as to induce him to repeat the operation. In his work on "Deformities," Mr. Tamplin* observes, "section of the muscles has been freely performed on the Continent for lateral curvature. I once divided them in a case that admitted only of relief, and with as much success as I could have anticipated, the back certainly yielded quickly, up to a certain point, but the difficulty that presents itself is the great sense of weakness that follows, together with the necessity for the most complete support during the time the ligaments are gaining strength; so that I cannot perceive that any advantage is gained by this proceeding,

* "On the Nature and Treatment of Deformities," by R. W. Tamplin, London, 1846.

as I believe any case that admits of relief or cure can be quite as quickly restored without the operation as with it."

The theory of M. Guérin, so ably and so forcibly advocated by its author, at one time impressed me with its importance, and with a desire to put it to the test of practical experience. I, therefore, in the year 1856, selected a case, a girl under my care at the hospital, in whom there was an unusual degree of prominence and tension of the spinal muscles, in the lumbar region on the convexity of the curve; in the dorsal region also the muscles on the convexity of the curve were tense and prominent. A drawing from a cast taken of this case is represented in Fig. 31.

FIG. 31.



Case of double lateral curvature, showing in lumbar region unusual prominence and tension of the spinal muscles, which I divided subcutaneously.

My late colleague, Mr. Lonsdale, concurred with me in the opinion that this was a fair case for testing M. Guérin's operation, and therefore I divided subcutaneously the muscles on the convexity of the lumbar curve, making a deep and free division.

Immediately after the operation two or three fingers could

easily be placed in the gap between the divided extremities of the muscles. No inflammation or ill effects followed. Mechanical treatment was afterwards adopted in the usual way, and the case proceeded favourably. However, Mr. Lonsdale and myself considered that the improvement was not greater than could have been effected by mechanical treatment alone, and as subsequent investigations led me to the opinion that the muscles usually found tense and prominent on the convexity of a curve are exerting their power beneficially to prevent increase of, rather than to produce a spinal curvature, I determined on physiological grounds to reject the operation, which I have not therefore repeated.

In connection with this subject, viz., the operation proposed by M. Guérin of dividing the spinal muscles, I would allude to a post-mortem examination, made in 1841 by my colleague, Mr. Gay,* of a woman aged 23, who had for many years suffered from a severe curvature of the spine in the dorsal region; she died of fever, and from his account of the dissection the following quotation is extracted:

"On removing the integuments, the muscles of the chest, both before and behind, were found to be but very feebly developed, and pale. The intercostals on the left side had lost the usual characteristics of muscular tissue, and become, to all appearance, degenerated to a mere membranous expansion. The sacro-lumbalis and longissimi dorsi, together with the powerful aponeurosis from which many of their fibres arise, were, on the other hand, comparatively large and powerful. The abdominal muscles were similarly proportioned, although they partook of the general feebleness of integral structure. On opening the abdomen, the diaphragm was observed to be very powerful; its muscular and tendinous portions were tense and strong, and its ascent into the cavity of the chest was unusually high.

"At this stage of the dissection an attempt was made to straighten the spine, by applying extension to both extremities, which caused the sacro-lumbar fascia to become tense and

* "London Medical Gazette," December 24th, 1841.

resistant. That structure having been divided by a transverse incision, the forces were re-applied, and a very trivial amount of elongation was evinced by the separation of the sides of the wound in the fascia just mentioned, to the extent of half an inch; but of the muscular bands, which, during life, were brought into very marked and energetic contraction by similar means, no traces whatever could now be discovered.

"All the muscles which are known to affect the spinal column were now removed, together with the contents of the chest and abdomen, and a further attempt made to reduce the curve; but it was perfectly unavailing, beyond the slight yielding recently referred to. Force was now applied in other directions, with the same end in view; but, in despite of all, the column retained its curvature.

"The general appearance which the walls of the chest presented, as far as the ribs were concerned, was that of their having been drawn downwards beyond their proper sphere of action by the abdominal muscles, and flattened or rather bulged inwards by the diaphragm.

"The intervertebral fibro-cartilages, along the whole course of the curve, had become thinned on its concave, and thickened on its convex side, apparently the result of interstitial absorption and deposition, and consequently retained no power of resilience to aid, or passive elasticity to permit, the restoration of the spine to its normal shape, in the event of other obstacles having been removed.

"The foregoing examination I have considered to be sufficiently important to merit the attention of the profession, as it bears upon the question as to the admissibility of operations in cases of spinal curvature. The division of fibres of the erector muscles of the spine, or rather of the aponeurosis to which the principal masses on the one side are attached, has been much practised, with the view of permitting the column to be straightened by the after use of mechanical agents. The adoption of such a course of treatment has obviously been founded upon a fancied analogy between these and other

distortions, such as clubbed foot, contraction of the knee-joint, &c."

Before taking leave of the *muscular theory of the production of lateral curvature*, in which may be included the several explanations which have been offered as to the way in which the muscles produce spinal distortion, I ought to allude to *the theory of Dr. Dods* to whose description of rotation of the spine I have already adverted in the account given of the morbid anatomy of lateral curvature.

In describing the movements of the spinal column, Dr. Dods observes:* "If we look again at the spinal column and observe its motions, we shall find that these, although limited in extent, are not so in direction, for we cannot only bend the spine directly forwards and backwards, but we can rotate it to a considerable extent, as we observe when turning round the body to look behind us." Then at page 87, after describing the origin of the *long extensors* of the back, viz., the *sacro-lumbalis*, and *longissimus dorsi*, with the *quadratus lumborum*, from the pelvis, and their insertions at certain given angles into the transverse processes of the vertebræ and the angles of the ribs he observes, "it is evident then, that as these muscles are inserted into transverse levers, they become muscles of rotation as well as extension. For example, if the extensor muscles on both sides of the spine be thrown into equal action at the same moment, the motion produced will be direct extension of the column, but if they be thrown into action only on one side, the spine, although made to incline in the direction of the muscular force, to that side, will be moved by means of the rotatory movement of the vertebræ."

"If the extensors of the spine, then, from being inserted into transverse levers (the transverse processes of the vertebræ) be constituted muscles of rotation, when they act on one side only, it will follow, that should disorganization, producing contraction, take place in those of one side, the effect of this

* "Pathological Observations on the Rotated or Contorted Spine, commonly called Lateral Curvature," page 88, by Andrew Dods, M.D. London and Edinburgh, 1824.

contraction, by its overbalancing the action of their fellows on the opposite side, will be to rotate the vertebræ to which they are attached and destined to move; and consequently to produce rotation or contraction of the column and not curvature."

The muscular contraction, to which Dr. Dods refers, he does not consider to be of a spasmodic character, or to depend upon any abnormal condition of the nerve centres, as supposed by the theory of M. Guérin, but to result from frequent and protracted voluntary muscular efforts to keep the body in the erect position under the restraining influence of school discipline; *i.e.*, young ladies being compelled either when sitting or walking always *to keep themselves erect*. The progressive effects produced upon the muscles of the back by the constant state of tension are supposed by Dr. Dods to be "in the first place, debility; secondly, a wasting of their substance; and lastly, permanent contraction of their fibres."

Although much credit is certainly due to Dr. Dods for his original observations on rotation of the spine in lateral curvature, there can be no doubt that the theory by which he attempted to explain the production of this distortion is essentially incorrect, and involves several anatomical and physiological errors. In the first place, he assumes that rotation of the spine is a natural movement which the spinal column possesses to a considerable extent in a state of health, and in illustration refers to the position which we assume when twisting the body round to look behind us. I have satisfactorily shown that horizontal rotation of the bodies of the vertebræ—such as would be required to give the spiral twist to the vertebral column—exists only in the most limited degree, if, indeed, it can be said to exist at all, in the lumbar region, where lateral curvature frequently commences, and is effectually prevented by the form and direction of the oblique articulating processes; whilst in the dorsal region the natural movement of horizontal rotation of the bodies of the vertebræ exists only to a very limited extent.

The assumed rotation movement of the spine being disproved by reference to the anatomical and mechanical construction of the articulations of the vertebræ, it is unnecessary to discuss the physiological assertion that the extensor muscles of the spine also become muscles of rotation, in consequence of their insertion into the transverse processes and angles of the ribs, which in reference to the bodies of the vertebræ are considered by Dr. Dods as transverse levers.

(The muscular theory of causation has also received support from two recent writers on the subject of lateral curvature of the spine, viz., Mr. Barwell and Dr. Sayre. In introducing his theory, Mr. Barwell* states that the normal antero-posterior curves in the lumbar, dorsal, and cervical regions of the spine are produced during infancy by muscular action. It is impossible to accept this statement as a physiological fact; the form of the spinal column is admirably constructed to meet the requirements of man, and to maintain the erect position of the human body; and the perfection with which it is adapted to this function is essentially dependent upon constructural design in the development of the various component parts of the organism, not of the muscles only, but also of the bones, ligaments and cartilages. Mr. Barwell, reasoning from his own view of the physiological origin of the normal curves of the spine, endeavours to account for its pathological condition of curvature by ascribing the occurrence of rotation to the influence of muscular contraction. The dorsal vertebræ, he states,† are, by the action of the serratus magnus muscle which converts the ribs into levers of the second class, rotated in a horizontal direction. The fallacy of this theory, as Mr. Fisher has observed,‡ is apparent when we consider that before the serratus magnus can act, the scapula must be fixed by the trapezius and rhomboidei muscles, and that therefore the spinous processes of the vertebræ from which these muscles take origin must also be stationary, so that the

* "Curvatures of the Spine," by B. Barwell. Third Edition. Macmillan and Co., London. 1877. Pages 5 *et seq.*

† *Loc cit.*, pages 27 *et seq.*

‡ See "Lancet," November 7th, 1879.

vertebræ must at the same time act as fixed points and become rotated, an evident impossibility. Dr. Sayre's theory is precisely similar to the one just discussed,* the objections urged against Mr. Barwell's views will therefore equally apply to the theory advocated by Dr. Sayre.)

The purely mechanical explanation given by Mr. A. Shaw of the mode in which rotation of the vertebræ takes place, will, I believe, be found correct.

According to this explanation, rotation of the bodies of the vertebræ is assumed to take place at the commencement of spinal curvature, and previous to any lateral deviation traceable externally. It is supposed to be directly caused by the weight of the body being thrown upon the oblique articulating processes, which are situated posterior to the bodies of the vertebræ, as well as laterally, and naturally resist and limit the lateral flexion of the spinal column. Hence, when the pelvis is tilted from any cause, such as standing on one leg, sitting in a bad position, &c., the body is thrown to one side. In this attitude, these processes resist the lateral inclination, in combination with such muscles as, in the position of the body assumed, are called into play. If, however, this faulty position be long continued, the oblique articulating processes are no longer able to resist the superincumbent weight of the body, and gradually become altered in form, so that the position becomes fixed and permanent.

As the oblique articulating processes yield to the pressure thrown upon them, so the bodies of the vertebræ deviate laterally, as shown in diagram, Fig. 23; or as Mr. Shaw has more correctly described it, wheel partly round, the centre of motion being fixed in the articulations between the oblique articulating processes which are situated posteriorly, as well as laterally, in respect to the bodies of the vertebræ.

This subject of rotation of the vertebral column in lateral curvature, was brought before the British Medical Association, in

* "Spinal Disease and Spinal Curvature," by Louis Sayre, M.D. New York. Smith, Elder and Co. London, 1877, page 92.

a paper contributed by my friend, Dr. H. Dick.* The following quotation is from the published abstract of the paper referred to: "Deformity of the spine, whether to the right or the left, is generally (improperly) called lateral curvature of the spine.

"Real lateral curvature of the spine is only found directly after pleurisy, with exudation, or after abscesses in the costal region. It is generally produced by post-inflammatory contraction and position during the pleurisy.

"All other cases of lateral curvature of the spine are more or less combined with rotation or twisting of the spinal column itself. This twisting has been found by Dr. Dick in a good number of post-mortem examinations to exist even in the very early stages of lateral curvature.

"After much observation and numerous experiments, Dr. Dick has arrived at the conclusion that the twisting is purely the mechanical consequence occasioned in the deviated or curved spine by bending it forwards. The spine in some respects resembles a strong elastic stick or column, which if pressed at both extremities more strongly than it can bear, forms a bow, and in that condition will not bend backwards or forwards, but will rotate at the central points of the bow.

"If a strict examination is made into the pathological anatomy of spinal curvature, the same rule above mentioned holds good.

"The misplacements of the scapula, ribs, &c., are in a great measure the results of that rotation just alluded to. The flat position of the spinous processes and other morbid changes are all ascribable as natural results of that abnormal twisting or rotation of the spine.

"An ingenious contrivance, which was exhibited to the Society, practically demonstrated the mode of producing that rotation, which, according to mechanical law, occurs in the deformed spine."

* See "Medical Times and Gazette," August 20th, 1864, for abstract of Dr. Dick's Paper.

Other Theories of the Production of Lateral Curvature.

Many of the older writers believed this affection to be essentially of a strumous nature, like the posterior or angular curvature, Pett's disease, and considered it to depend upon *scrofulous softening of the bones*. Others, again, believed it to be generally produced by *rickets*; and even at the present time rickets is much too frequently assigned as a cause of this affection.

Amongst the various theories which are to be found in the medical literature of this subject, is one which you will meet with in books on *lateral curvature* written by authors, who combine the popular element largely in their literary productions. I allude to the theory of *tight lacing*. And in such works we find the cause of this deformity largely attributed to, and a vehement attack is made against, the fashion of wearing stays and tight lacing.

Independently of the class of writers to which I have referred, it is curious to observe how widely orthopædic authorities differ as to the influence of stays and tight lacing in producing lateral curvature. The late Mr. Tamplin altogether rejected this as a cause, and observed, "various causes of spinal curvature have been assigned by numerous writers; amongst others, the use of stays, which most certainly of themselves do not produce this deformity, for they are worn by all classes of society; whereas, the rich and affluent are the most frequent sufferers from spinal affections."* Mr. Tamplin considered that "general debility, or simple loss of the general tone, is of all others the most frequent cause of this deformity," and he dwelt more especially upon the effects of *boarding-school routine* as contributing to this debility and feeble muscular development. There can be no doubt of the general truth of these remarks.

My late friend and colleague, Mr. Lonsdale, never joined in the condemnation of stays and tight lacing as a cause of lateral

* "On Lateral Curvature of the Spine," by R. W. Tamplin, page 20, Churchill, 1852.

curvature; but he considered that the use of stays and the practice of tight lacing, when this habit existed, would in some degree explain the direction of the curvature to the right side, because the pressure being equal, less resistance to this pressure would be offered on the left side, in consequence of the smaller size of the left lung, and the presence of the liver on the right side.* Mr. Lonsdale believed more in the influence of any long continued position of the body, as in various occupations, nursing children, &c., producing curvature of the spine by the mechanical weight of the head and upper extremities, acting unfavourably on the vertebral column; with this opinion I certainly concur, as to the immediate and mechanical cause.

Mr. Brodhurst, on the other hand, attaches the highest degree of importance to the influence of stays, as the commonest cause of lateral curvature of the spine. He observes: "By the use of the corset the action of the muscles of the back are restrained. Wasting of the muscles and relaxation of the spinal ligaments is induced—local debility, which is the commonest cause of lateral curvature of the spine. . . . And the use of the corset being general amongst our female population, it follows that this being a prominent cause of muscular debility, lateral curvature of the spine is also frequent."†

In consequence of stays being less constantly worn by the lower orders, Mr. Brodhurst considers that lateral curvature of the spine is less frequently observed in the labouring classes, "and for the same reason boys are seldom, if ever, affected with this form of curvature."

In the writings of the French and German orthopædic authorities we do not find any importance attached to the use of stays, and the habit of tight lacing as a cause of spual curvature. Bouvier,‡ who devoted much attention to this

* "On the Treatment of Lateral Curvature of the Spine," page 21, by E. F. Lonsdale. Churchill, 1852.

† "On Lateral Curvature of the Spine," page 11, by B. E. Brodhurst. Churchill, 1855.

‡ "Dictionnaire de Médecine et de Chirurgie Pratiques." Supplément. 52 u. ione, Zinc, tome 15, à Paris, 1836. Art. Vertébrale. Deviation de la Colonne, par M. Bouvier.

subject, makes no mention of the use of stays and the practice of tight lacing as a cause of lateral curvature ; but taking a broader view of the subject, considers that the conditions necessary to the production of this deformity are : 1st, that the parts composing the spinal column have little solidity, and 2nd, that the different powers which act upon the spine produce unequal pressure continuously, and always in the same direction. Therefore he arranges the causes in two classes ; the one *organic*, which, acting from within, predispose the structures of the vertebral column to suffer from unequal compression ; especially he adverts to the feeble powers of resistance offered by the vascular and cancellous bodies of the vertebræ, and the soft intervertebral cartilages during the period of active growth — and the other *mechanical*, which by their action in disturbing the equilibrium of the spinal column, produce the unequal compression of its yielding structures.

There can be no doubt of the accuracy of these views, and that Bouvier recognized the importance of the constitutional conditions, as well as the local causes, which tend to produce deviation of the spinal column.

In addition to the weight of opinion against stays and tight lacing as a cause of spinal curvature, I would direct attention to a few practical points which appear to me not only to decide this question, but to have a more general significance in relation to other causes and mode of production of lateral curvature. 1st. According to my experience, the most severe and intractable cases of lateral curvature—those most disposed to terminate in conspicuous deformity—commence, as a general rule, at a much earlier period of life than stays are ever worn. We all know that it is only when a girl by her growth and development shows the usual signs of womanhood, that stays are thought necessary to improve or mould her figure ; and in the present state of public opinion against stays and tight lacing, it is so little the custom of mothers to allow their daughters either to wear stiff stays, or to lace tightly, that it would be difficult to find any examples of the practice ; they may at least be said to be rare exceptions to the general rule.

But, as to the age at which severe cases of lateral curvature most frequently commence, I have no hesitation in stating, that if we omit those which occur in infancy and early childhood, say before five years of age, which are generally of an hereditary character, the next class—a very numerous one—are those which most frequently commence between the ages of seven and twelve years. These cases have also, not uncommonly, a history of hereditary tendency, but in many instances this cannot be traced, and the constitutional cause seems to consist in a strumous diathesis. Consumption is very frequently to be traced in the family history, and the death of the mother by this disease is of common occurrence.

Whether the cases included in this class are numerically equal to, or exceed those in the next class to which I shall allude, viz., such as occur between the ages of twelve and sixteen years, I am unable to say from statistical data; but speaking from private practice, I think they are at least as frequent, if not more so. Still keeping below the age at which stiff stays are commonly worn, or tight lacing indulged in, we have the class of cases of lateral curvature in quickly growing girls between the ages of twelve and sixteen years. This is assumed to be the typical and popular class of cases by the great majority of authors on lateral curvature, and these cases are supposed to be produced by a variety of local causes acting mechanically, such as result from bad habits of standing upon one leg, various occupations, &c., and undoubtedly these local causes are frequently to be traced in the history of the cases which occur at this period of life; but some predisposing constitutional conditions may also generally be found. Growing too fast, or “outgrowing the strength” is the popular explanation; and there can be no doubt that rapid growth would predispose to curvature of the spine, when coexisting with any of the local or constitutional causes above enumerated.

The two classes of cases, occurring within the periods above mentioned, include the great majority of cases of lateral curvature which are brought under the notice of the surgeon;

and the cause which can least frequently, if ever, be traced under the age of sixteen years, is the practice of wearing stiff stays and the habit of tight lacing.

Then again I would observe, that the cases of lateral curvature which commence after the age of sixteen years, some of which might with greater reason be supposed to depend upon the wearing of stays and tight lacing, are not only few in number, as compared with those which commence before this age, but essentially are of a mild and tractable form, not disposed, even without any treatment, to terminate in conspicuous deformity. They depend chiefly upon local causes, the removal of which contributes to arresting the progress of the curvature.

Next let us consider the positive evidence, and inquire whether lateral curvature of the spine can be directly traced to the habit of wearing stays and tight lacing in young ladies who are undoubtedly in the habit of improving their figure, as they suppose, by this absurd and injurious practice? There can be no doubt that the habit of tight lacing does exist, and is by no means uncommon with young ladies moving in society, and no longer under the direct control of their mothers: but amongst these young ladies, generally between the ages of sixteen and twenty years, do we, or do we not frequently see examples of lateral curvature? According to my experience we do not: sufficient punishment is in store for most of these young ladies with small, and so-called "*pretty waists*," but lateral curvature is not, I believe, amongst the evils to which they expose themselves by this pernicious habit.

We may, without difficulty, find a few cases of lateral curvature coexisting with the habit of tight lacing, and two or three have fallen under my own observation; but in these instances the spinal curvature commenced before the tight lacing, and has certainly not increased, though the habit of tight lacing has been persevered in for several years; indeed it would almost seem as if the support afforded by the stays tightly laced had contributed to the arrest of the spinal curvature.

In the best marked example I have ever seen of a very small waist undoubtedly produced by tight lacing in a young lady now over twenty years of age, slight lateral curvature coexists, but it certainly began between the ages of twelve and sixteen years, and has not increased of late (1865); moreover, she belongs to a family in which there is a very marked tendency to lateral curvature—three sisters have each a large family, and in each family there are two daughters affected with lateral curvature. My patient with the small waist, produced by tight lacing, aided it has been said by pulling the stay lace round the bed-post, is the least curved of six in her family.

Another series of facts bearing upon the present subject may be here adverted to. All those who have had much experience in making post-mortem examinations must be familiar with the appearances presented after death, in the bodies of women who have produced small waists by tight lacing. In these cases we see the lower ribs permanently depressed and altered in form in the line of constriction; and corresponding to this depression of the ribs, we observe a transverse depression on the surface of the liver, which organ is itself altered in form, being more elongated than natural, compressed from side to side, and extending upwards so as to encroach upon the thoracic cavity.

I have seen many examples of this altered form of the liver with a deep transverse depression, corresponding to the depressed ribs which have been long constricted by tight lacing; and we cannot doubt that such changes must be accompanied with functional disturbance of the liver, as well as other symptoms, depending upon the interference with the free respiratory movements of the chest, and also upon the compression of the stomach.

But let us inquire whether lateral curvature of the spine is frequently met with in these cases? According to my experience it is certainly not. I never met with lateral curvature of the spine in one of these post-mortem examinations; so we may conclude that in cases in which tight lacing has

produced its worst effects upon the system, lateral curvature of the spine is not generally met with.

The practice of wearing stays and of tight lacing cannot therefore be regarded as a cause of lateral curvature of the spine, notwithstanding the importance which has been attributed to it, even by those whose experience in orthopædic surgery might be supposed to add weight to their opinion.

I have now passed in review the principal theories which have been advanced in explanation of the causes and mode of production of lateral curvature, viz. :

1st. The muscular and ligamentous theory; which I have determined to reject, mainly on anatomical and physiological grounds, and also as being opposed to the facts of my observation and experience.

2ndly. The theory of M. Guérin, of active or tonic muscular contraction. This I also determine to reject, principally on physiological grounds, as well as from practical experience and observation.

3rdly. The theory of Dr. Dods, which I also reject on anatomical and physiological grounds; and as altogether insufficient to explain the phenomena of rotation, to which he has the credit of first directing the attention of the profession.

4thly. The theory advanced by Dr. Dick, of rotation of the vertebræ. This is not in accordance with my views, as it supposes lateral curvature to precede rotation; whereas I believe rotation to precede any lateral deviation of the spinal column, and its cause and mode of production to have been accurately explained by Mr. Alexander Shaw. In reference, however, to the increase and subsequent progress of the distortion, the views of Dr. Dick are accurate and important.

5thly. The importance attributed as a causative influence to stays and tight lacing. This I reject altogether as contrary to observation and experience, as unsupported by direct evidence, and opposed to a number of facts which I have pointed out in the clinical history of lateral curvature.

In explanation, therefore, of the causes and mode of

production of lateral curvature, I look essentially to a combination of constitutional and local causes, which I have enumerated, and described as the *predisposing* and *proximate* causes of this affection; and upon this basis I have arranged a classification of the cases into three classes, and endeavoured to determine the principles of treatment applicable to each class.

* * * * *

Note.—Dr. Judson,* of New York, has recently endeavoured to explain the cause of rotation of the bodies of the vertebra, and from his interesting observations on this subject I extract the following:

“In the present unsettled state of the question, I propose an explanation as follows:

“The rotation of the vertebra in lateral curvature of the spine consists in an unequal lateral displacement of the body and the spinous process, the former being free from lateral attachments, and therefore departing from the median plane, while the latter is held in the median plane by its muscular and fibrous attachments.”

The muscles attached to the vertebral column, and also the ligaments, aponeuroses, and fascia are then minutely described, especially in reference to their function of holding the spinous processes, and the posterior part of the spinal column in the median plane of the body. Dr. Judson afterwards observes:

“While the spinous processes of the vertebral column are held in the median plane of the trunk by the strong and active fibrous and muscular structures which are attached, on one hand, to the posterior portion of the spinal column, and, on the other hand, to the shoulders, the thoracic and abdominal parietes, and the hips; the anterior portion of the vertebral column is comparatively free from fibrous and muscular attachments. . . .

“When the median plane of the trunk curves to the right or

* “The Cause of Rotation in Lateral Curvature of the Spine,” by A. B. Judson, A.M., M.D., New York. *Transactions of the New York Academy of Medicine*—read April 6th, 1876. Reprinted. Appleton & Co., Broadway, New York. 1876.

the left, under the vertical pressure which is *the direct cause of lateral curvature*, their freedom from control allows the bodies of the vertebræ to fall away from the median plane, to the right or the left, while the posterior portions of the column are held in the median plane by their muscular and fibrous attachments. This deportment of the two components of a vertebra, its anterior and posterior portions, is rotation in the vertebra as a whole.

“In mechanics, rotation in a given body may be on a central axis, a peripheral axis, or a remote axis.

“The rotation of a vertebra in lateral curvature is rotation on a remote axis.”

From the above quotations, it will be seen that Dr. Judson's view of the cause and mode of production of rotation does not materially differ from that of Mr. A. Shaw; although the influence of the muscles in preventing or limiting the deviation of the spinous processes appears to be an original observation, in the accuracy of which I concur.—W. A.



LECTURE VII.

GENERAL PATHOLOGY OF LATERAL CURVATURE OF THE SPINE (CONTINUED).

Now let us proceed to the consideration of some other points in the pathological history of this affection. One question frequently asked, but of much less importance, I believe, than by some authors it is made to appear, is

Does lateral curvature of the spine more frequently commence in the lumbar or dorsal region? To this question I am unable to give a positive answer. In hospital practice, where patients usually apply to us in an advanced stage, and with conspicuous external deformity, we see a great predominance of the curvature in the dorsal region, and frequently with very little lumbar curve. The same may be said of some cases in private practice which first come under our observation in the late stage; but in the latter class, where we are frequently consulted as early as any indications present themselves, I have seen about an equal number of cases in which the tendency to curvature has first shown itself in the lumbar as in the dorsal region; so that I should be disposed to conclude that the local causes acting mechanically—upon which the curvature immediately depends—produce their effects about as frequently in the lumbar, as in the dorsal region; for example, all the causes which act from below, and produce obliquity of the pelvis, such as the habit of standing on one leg; sitting cross-

legged; excessive horse exercise; or any irregularity in the length of the legs; would cause the tendency to spinal curvature to exhibit itself first in the lumbar region.

On the other hand, all the causes which act from above, such as wry-neck, causing the weight of the head to be thrown to one side; carrying weights on one arm, such as nursing children, &c.; various occupations which throw the weight of the head and upper extremities habitually to one side; cause the tendency to spinal curvature to exhibit itself first in the dorsal region.

From what I have said, however, as to the appearances observed in the early and late stages, one inference may be drawn, viz.: that when a double curvature is actually formed, the tendency to increase is much greater in the dorsal than in the lumbar region. This may be explained by the greater length of the dorsal portion of the spinal column, and the mechanical effect which must necessarily be produced in this region, by the irregular distribution of the weight of the head and upper extremities, tending directly to increase the curvature, and produce conspicuous external deformity.

An undue importance has been attached to this question of the commencement of curvature in the lumbar, or dorsal region, by those who believe in what they call primary and secondary curves, *i.e.*, that a curvature is first formed in one part of the spine—the primary curve; and that only after this has formed and existed a certain time, a second curvature takes place, above or below the first, as it may happen to be, as a compensative effort of nature to preserve the equilibrium of the body.

So great is the importance attached, even by some orthopædic authorities, to this *primary and secondary curve theory*, that they consider the only principle upon which a spinal curvature can be cured, is first to determine which has been the primary curve, and then by removing this, the second or compensating curve cures itself spontaneously; and further it is considered that the removal of the compensating curve would even occasion an increase of the primary curve. Mr. Brodhurst, has more

especially advocated this theory, and states the following as his conclusions :

1st. That there are many causes of spinal curvature.

2ndly. That the position of the primary curve differs as the cause which produced it.

3rdly. That to remove mechanically a compensating curve, is to increase the primary curve.

4thly. That removal of a compensating curve, is effected by acting on the primary curve.

And that, consequently, it is essential to determine which is the primary curve, that through its removal the perpendicular line of the column may be restored.*

The fact is, however, that the necessity for this compensative effort of nature exists from the moment the equilibrium of the spine is disturbed, and if this disturbance be continued long enough to produce a persistent curvature, however slight, a double and not a single curvature, is always formed. The two curves are frequently of very unequal length, the dorsal generally being the longer, and therefore, as a rule, the increase of the dorsal proceeds much more rapidly than the lumbar curve, even when the disposition to curvature has first shown itself in the lumbar region. Hence it is that in the more severe cases of curvature we see external deformity depending upon the increase of the dorsal curve, and it is the increase of this curve, that we are called upon to arrest, when the case has advanced beyond the period at which a cure could be effected.

To suppose either that this increase can be prevented, or that the dorsal curve can be removed, by means directed solely towards the diminution of the lumbar curve—because the disposition to curvature has first been evinced in the lumbar region—appears to me to be most irrational ; though, of course, if any obvious cause of tilting of the pelvis existed, such as a short leg, &c., we should not neglect, as a part of the treatment, to compensate for this inequality, and as far as possible restore the pelvis to its normal position.

* *Op cit.*

Another point of interest in the pathological history of lateral curvature of the spine refers to the much greater liability to this affection which exists in the female than in the male sex, a fact of which I shall endeavour to offer a satisfactory explanation. First then with regard to the

Relative liability of the sexes. So much more frequently does lateral curvature of the spine occur in the female than in the male sex, that surgeons who have not the opportunity of observing this affection on a large scale, as we see it at the Orthopædic Hospital, are apt to believe that females only are liable to it.

Now, as this question of the relative liability of the sexes can alone be settled by reference to statistics, we must refer to such evidence as we possess. It is somewhat unfortunate that in the statistical table of the largest number of cases of deformities which has been published from the records of the Orthopædic Hospital, viz., the table of 10,217 cases published by Mr. Tamplin,* although 647 cases of lateral curvature were recorded, no mention of the sexes is made. In this table, the only point determined is the relative frequency with which the most prominent curve is directed either to the right or the left side. But in a table of 3,000 cases of deformities which had been jointly under the care of my late colleague, Mr. Lonsdale, and myself—recorded in *The Lancet* of September 1st, and September 8th, 1855—173 cases of lateral curvature of the spine are reported, and of these 151 occurred in females, and 22 only in males. Lateral curvature, therefore, occurs in females, according to these tables, in the proportion of seven to one.

The question may very fairly be asked ; *whether the cases of lateral curvature of the spine, reported as occurring in boys, were in all respects identical with those generally observed in girls?* Anatomically considered, there can be no doubt that the cases are in all respects identical, whether met with in boys or in girls ; but with reference to the causes producing the curvature,

* Introductory Lecture, October 13th, 1851, reported in the "London Medical Gazette."

it is equally certain that the cases occurring in boys generally correspond with that class of cases in girls, which I have described as "depending essentially upon local causes acting mechanically so as to disturb the equilibrium of the spinal column," and these cases I have arranged in the third class. Comparatively few of the cases occurring in boys correspond to those I have arranged in the second class, viz., "cases depending upon constitutional and local causes in about equal degrees;" and still more rarely do they correspond to the first class, *i.e.*, cases essentially of constitutional origin."

I now exhibit to you a few models of cases of lateral curvature in boys under my care at the Orthopædic Hospital, which may serve to illustrate the clinical history of these cases. The first is taken from a boy who had been employed at a pawnbroker's shop. The deformity presents the ordinary appearance of double lateral curvature, with the large curve in the dorsal region to the right side. The boy is a stout, muscular, healthy-looking lad. He was for some years in the habit of carrying goods to the top rooms in the house, passing up a spiral staircase, in ascending which he was obliged to stoop and always lean towards the left side; and to this he attributes, I think correctly, the production of the curvature. It is difficult to imagine what would produce a curvature of the spine in such a boy, except the long continuance of some bad position combined with the carrying of heavy weights.

The second case is that of a young man, who is now engaged as a postman. The curvature here is less considerable than in the preceding case, but is also principally in the dorsal region, and to the right side. You might be inclined to suspect that this curvature had been induced by his occupation, and especially by the excessive use of the right arm in knocking at doors; but although the curvature has increased of late, the man was aware of its existence before he became a postman.

In the third case, the cast was taken from a boy who had been working in a gold-lace factory for two or three years, and was accustomed to wind the lace, which obliged him to lean

downwards on the right side, the right arm being used; the curvature, in this case, formed chiefly in the lumbar and lower dorsal region, the convexity being towards the left side, and had evidently been produced by the habit of stooping, or bending downwards, towards the right side.

Many other instances might be given, but these are fair examples of lateral curvature of the spine occurring in muscular boys, and produced by local causes acting mechanically.

It is stated in books that when lateral curvature occurs in boys, the convexity of the curve, *i.e.*, of the largest and most prominent curve, is generally directed towards the left side; whilst in girls it is well known that the convexity is generally towards the right; but I have seen many instances of the curvature projecting towards the right side in boys. Without being able to decide the point by our hospital statistics, in which attention has not been directed to this point, my opinion is that the statement has been made much too broadly.

Now the question is also frequently asked:

Why does lateral curvature of the spine occur so much more frequently in females than in males?

By those who believe that lateral curvature rarely occurs except in young ladies belonging to the middle and upper classes of society, and that it generally, or almost invariably depends upon muscular debility and relaxation of the ligaments, the above question is readily answered. We are told that young ladies wear stays, and that nothing so certainly induces muscular debility as the use of the corset; that they are enfeebled by long hours of study, upon the high-pressure-system of education; that they sit many hours a day, either at drawing, writing, music, needlework, &c., in constrained and unnatural positions; that whilst thus engaged they generally use the right arm more than the left; and that they are in a great measure excluded from the free muscular exercises in which boys habitually indulge.

But these explanations, which are based upon the idea of muscular debility as the producing cause, will not account

for that large proportion of cases—nearly half of the whole number—in which no evidence of muscular debility exists.

The theory of the excessive use of the right arm I have rejected, believing that the position assumed by those who habitually employ the right arm more than the left, is of more importance as a producing cause of curvature, than the undue exercise of any particular set of muscles.

There can be no doubt that girls are more predisposed than boys to suffer from constitutional causes, on account of their greater delicacy of organization, which renders their powers of resistance to the influence of local causes less than in boys; and that in the middle and upper classes, girls unnecessarily expose themselves in a greater degree to the local causes, by habitually sitting or standing in bad positions; whilst in the lower classes, these positions may be rendered compulsory by their occupations. Hence the greater frequency of lateral curvature amongst girls, a fact to be the more regretted because the local causes which either singly, or in combination, directly tend to produce the curvature, are in most instances preventible.

Another fact of some interest in the clinical history of lateral curvature of the spine, although it can hardly be considered as having any practical importance, is the remarkable frequency with which the curvature in the dorsal region takes place towards the right side, and the curvature in the lumbar region towards the left; and various theoretical explanations have been given in answer to the question,

Why does the curvature in the dorsal region more frequently take place to the right side? The fact that the convexity of the curve in the dorsal region is directed towards the right side in a large majority of cases is indisputably proved by statistics. In the table of 10,217 cases of various deformities published from the books of the Royal Orthopædic Hospital already referred to, 647 cases of lateral curvature of the spine are recorded, and in 569 of these, which were of the ordinary nature, and free from any complications, the direction of the curvature is stated to have been as follows :

To the right side	.	.	.	.	470
To the left side	.	.	.	.	99
					<hr/>
Total					569

The relative proportion, therefore, of cases in which the convexity of the curve in the dorsal region is directed towards the right side is, according to the above table, nearly as six to one. This is not so clearly stated by Mr. Tamplin, who drew up the table, in which he merely observes that the curvature was to the right or left respectively, without mentioning the dorsal or lumbar region, but in stating this I believe he alluded only to the deviation of the curve in the dorsal region.

In the table of 3,000 cases of various deformities which had been under the care of Mr. Lonsdale and myself, already referred to, 173 cases of lateral curvature of the spine are recorded, and of these in 149 the convexity was to the right side, and in 24 the convexity was to the left.

Bouvier states that "the deviations of the middle dorsal region to the left are more rare than to the right in the proportion of one to seven."*

There can be no doubt of the fact, therefore, that in cases of lateral curvature, the convexity of the curve in the dorsal region is directed towards the right side more frequently than to the left, in about the proportion of six or seven to one. Various explanations of this fact have been given according to the views of the different authors as to the producing cause of lateral curvature.

1st. We have the theory that the convexity of the curvature to the right side in the dorsal region, is merely an exaggerated degree of a natural condition ; that, in fact, as the spine naturally curves towards the right side in the dorsal region, we might expect to find this condition increased when the spine becomes curved from debility or other causes.

2nd. The theory of excessive use of the right arm and muscles of the right side. This is the favourite explanation

* *Op cit*, page 669.

given by those who believe in what I have described as the *muscular theory of the production of lateral curvature*, a theory which although the most popular with the profession at the present time, I have endeavoured to disprove upon anatomical and physiological grounds. I need only, therefore, refer you to the arguments used when discussing the general theory, and express my opinion against this explanation of the dorsal curvature projecting towards the right side.

3rd. The excessive use of the right arm combined with the influence of position in various occupations and educational pursuits. This combination of causes, by the addition of the influence of position, brings us more nearly to the truth, though I believe that the influence of position is alone sufficient to explain this peculiarity in the direction of the dorsal curve, and that the addition of the muscular influence is both unnecessary and incorrect.

My late colleague, Mr. Lonsdale, admitted the excessive use of the right arm, and the long continuance of certain bad positions, as causes tending to produce curvature of the spine in the dorsal region, with the convexity of the curve towards the right side; but he also thought that the influence of these causes alone was insufficient to produce this peculiarity in the direction of the dorsal curve, and believed that it in some degree resulted from the co-operation of internal causes.

He considered that whilst the left side of the chest was mechanically compressed, and respiration on this side more or less impeded in the positions above referred to, such as sitting at needle-work, writing, drawing, &c., the greater expansion of the lung on the right side, which is naturally larger than the left, favoured the curvature of the spine to the right side, and tended to increase it when the curvature had actually commenced.

These views of Mr. Lonsdale's as to the influence of the unequal size and expansion of the lungs, and the resistance offered by the liver to compression on the right side, although well worthy of attention, do not appear to me to render the

explanation of the dorsal curvature to the right side more satisfactory; and if we believe that lateral curvature of the spine commences as frequently in the lumbar as in the dorsal region—which I have stated to be the case according to my experience—it will be seen that Mr. Lonsdale's views are only of limited application, and leave the explanation of the cases in which the curvature commences in the lumbar region only the more difficult and obscure; and those in which the convexity of the curve in the dorsal region is directed towards the left side, are also rendered more difficult of explanation.

Another objection to these views, especially to the lung expansion on the side of the convexity increasing the curvature after it has commenced, also occurs to me in the anatomical fact, proved by dissection, that the capacity of the thoracic cavity on the side of the convexity of the curve, is positively smaller than that on the side of the concavity, in consequence of the bodies of the vertebræ being directed towards the convexity by the movement of horizontal rotation, and also in consequence of the flattening of the ribs which invariably takes place on the convexity of the curve.

The thoracic cavity on the side of the convexity of the curve diminishes in proportion to the increase of the spinal curvature, and the thoracic cavity on the side of the concavity of the curve becomes disproportionately increased in its size and capacity. I have already described the influence of lateral curvature of the spine in causing displacement of the thoracic viscera by altering the relative capacities of the right and left sides of the chest.

For the above reasons, then, I am unable to admit these internal causes as explaining the frequency with which the convexity of the dorsal curve is directed towards the right side.

With regard to my own opinion, as to the cause of the greater frequency with which the convexity of the curve is directed towards the right side in the dorsal region, I think we can neither appeal to any peculiarity in the natural conformation of the spinal column, nor to any internal causes, such as the

situation and direction of the aorta, the relative size of the lungs on the two sides of the chest, the situation of the liver, &c., nor to any constitutional cause; and the explanation as to the undue exercise and contraction of certain muscles, or the excessive use of the right arm, I believe to be decidedly erroneous.

To me it appears that we must look to the mechanical conditions under which lateral curvature generally takes place, and by which it is immediately produced, either independently of, or in conjunction with, certain constitutional causes; and if we examine carefully the mechanical conditions under which the equilibrium of the spinal column is disturbed, for a sufficient length of time to produce the structural changes which always exist in lateral curvature, however slight, we shall recognise in these conditions a sufficient explanation of this peculiarity in the direction of the dorsal curve.

In most of the occupations followed by women, such as needle-work, flower-making, envelope and book-folding, &c., and during the many hours daily passed by growing girls whilst engaged in their educational pursuits, or in the acquirement of drawing, painting, fancy needle-work, especially where the frame is used, &c., they throw themselves into a position in which the right shoulder is raised, and the left depressed, the spine of course being curved with the convexity of the curve in the dorsal region directed towards the right side. This position they retain for many hours daily, so that the spine is always curved in the same direction.

When the curvature commences in the lumbar region from a habit of standing upon one leg, by which the pelvis is habitually tilted, the weight of the body is generally thrown upon the right leg, so that the spine in the lumbar and lower dorsal regions is curved with the convexity directed towards the left side, and consequently the compensating dorsal curve has its convexity directed towards the right side. The same effect is produced by sitting cross-legged when the right leg is thrown across the left, the usual position.

If then it be admitted that the immediate cause producing lateral curvature is essentially mechanical, depending upon the

long continuance of certain positions which cause an irregular distribution of the weight of the head and upper extremities through the spinal column, and if it can also be shown that these positions are generally such as would curve the spine so that the convexity of the curve in the dorsal region would be directed towards the right side, we have a sufficient explanation of this peculiarity in the direction of the curvature in the dorsal region.

Next let us proceed to the consideration of some points in the pathological history of lateral curvature of more direct practical importance, and pass in review the

Symptoms of Lateral Curvature, and its effects upon the General Health.

No affection can possibly be more variable as to its general symptoms, and its influence upon the health of the patient, than lateral curvature of the spine. In many cases, especially those which commence at an early period of life, say from seven to twelve years of age, and slowly but progressively increase to the production of the most severe degree of deformity, no symptoms, such as would interfere with the general health of the patient, may be present even up to the middle period of life; but in these cases, although the evil day is put off, it nevertheless arrives sooner or later, and the patient suffers from functional disturbance of the thoracic or abdominal organs to an extent which leads to the belief that serious disease of these organs exists.

In other cases, especially those which occur in growing girls and advance rapidly, between the ages of twelve and sixteen, the general health frequently becomes affected by the occurrence of spinal pain, functional disturbance of the digestive organs, general debility, and derangement of the uterine functions.

This remarkable difference in the symptoms and effects upon the general health appears to me to depend upon two circumstances, viz., the age at which spinal curvature

commences, and its rate of increase. In children the spinal curvature generally increases slowly, and the thoracic and abdominal organs gradually adapt themselves during their growth to the deformity of the body; but in the more fully developed girl the spinal curvature often increases rapidly, so that in two or three years I have seen extreme deformity produced, and no such adaptation of the internal organs can take place; moreover, the rapidity of the curvature is of itself sufficient explanation of the spinal pain which, by producing general exhaustion and debility, becomes the most prominent symptom, and induces functional disturbance of the digestive and uterine organs.

The symptoms of lateral curvature of the spine, and these effects of the distortion upon the internal organs which may be regarded as depending upon, and therefore symptomatic of, the spinal affection, may be best arranged, for practical purposes, in two groups or classes described as

Local and general symptoms. By *local symptoms* I mean those physical changes in the symmetrical form and proportions of the body which indicate the existence of the spinal distortion, and lead to external deformity. These physical changes have been already described in the account given of the external characters and morbid anatomy and pathology of lateral curvature in its different forms, and in different regions. I will now only briefly refer to the earliest deviations which may lead to the suspicion of lateral curvature of the spine existing, or which may clearly indicate its existence.

The local symptoms vary according to the region in which the curvature commences, and the direction and relative lengths of the different curvatures formed; for instance, whether it commences in the lower cervical and upper dorsal region—or in the middle dorsal region—or in the lower dorsal and lumbar region—whether the curve is what is generally called single or double, &c. The earliest local indications which at once point to the existence of a lateral curvature of the spine, and frequently explain the general symptoms under which the patient may have suffered for several months, are, when the

curvature commences in the *dorsal region*, some disturbance in the symmetrical form of the chest or position of the shoulders; an undue prominence, or *growing out* as it is called, of one shoulder, generally the right, is frequently first noticed;—or it may be observed that the girl, either when sitting or standing, habitually raises one shoulder, generally the right, and depresses the other;—or if the girl, perhaps at fourteen or fifteen years of age, should be fully developed in the chest, an undue prominence and apparent enlargement of one breast, generally the left, may be observed, together with a fullness between the clavicle and breast, caused by a prominence of the second and third ribs.

This alteration in the form of the chest in the early stage of lateral curvature, has already been shown to depend upon rotation of the bodies of the vertebræ causing *internal curvature*, which may exist without any external deviation of the apices of the spinous processes.

When the curvature commences in the lumbar region, a *growing out of one hip*, as it is called, or apparent enlargement of the hip, generally the right, may be first noticed, and is diagnostic of the existence of curvature of the spine in the lumbar region; the prominence of the hip being caused by the receding of the lumbar vertebræ, and the sinking in at the loin corresponding to the concavity of the curve.

The earliest local symptom, or indication of lateral curvature of the spine, which surgeons generally look for, and indeed the only one upon which they rely, is a lateral deviation of the apices of the spinous processes; but I have already explained when describing the anatomical changes which occur in this affection, that a lateral deviation of the apices of the spinous processes is by no means an essential condition in the early stages of lateral curvature, nor does it always occur even in the later stages or more severe forms of lateral curvature.

I exhibited to you two specimens illustrating this fact, one from a slight case of lateral curvature in which the lateral deviation of the bodies of the vertebræ was well marked, whilst the lateral deviation of the apices of the spinous processes could

scarcely be traced (see Plate II.), and the other from a severe case in which the internal curvature or deviation of the bodies of the vertebræ had reached almost an extreme point, whilst the deviation of the apices of the spinous processes was very slight—and even this could not be traced in the body previous to the removal of the specimen—the appearances of which are represented in Plates III., IV. and V.

By general symptoms I mean those which affect the general health by interference with the functions of the internal organs, either of the chest or abdomen ; such for example as palpitation of the heart, interference with free respiration, derangements of the liver, stomach and bowels. Amongst the general symptoms we may also include the pain which frequently accompanies spinal curvature, and may be referred either to the region of the spine, varying in its seat according to the situation of the curvature ; or as in some very severe cases in which the lower ribs are much depressed, it may be referred to the iliac fossa, as a deep-seated internal pain. We may also include spasmodic attacks which occur in some of these cases ; and a form of partial paralysis of the lower extremities, a condition occasionally met with and evidently depending upon the curvature of the spine, though the mode in which the paralysis is induced and its exact pathology are obscure.

First then with regard to the *functional derangement of the thoracic organs*. In slight cases of lateral curvature of the spine, when associated with general debility and occurring in girls, it is by no means uncommon for the patient to suffer from palpitation of the heart, with a disposition to fainting, &c., feeble and irregular pulse, symptoms which are essentially dependent upon the enfeebled condition of the general health, and usually associated with other functional disturbances of the digestive and uterine organs ; but in these cases the patients generally suffer also from spinal pain, sometimes described merely as *aching and a sense of weakness* of the spine, which is so much increased even by slight exertion, inducing sickness and loss of appetite, that they are compelled to abstain from taking any exercise whatever, and there can be no doubt that the

enfeebled condition of the general health is largely and directly dependent upon the existence of the spinal curvature.

The opposite view, however, is generally taken by those who see but few cases of spinal curvature, and the enfeebled condition of the general health, together with the associated functional disturbances, is regarded as the primary and essential affection to which the spinal curvature is merely secondary; medical treatment is therefore directed to the improvement of the general health, and the spinal curvature is neglected, except perhaps by the direction to the patient to lie down, which indeed becomes a matter of absolute necessity.

Now, admitting as I do the large share which constitutional causes take in the production of spinal curvature, I have no hesitation in stating that the correct practical view is to regard the symptoms just described as essentially dependent upon the curvature of the spine, and that mechanical support by a spinal instrument, without any constitutional treatment will, in many instances, be alone sufficient to remove all these symptoms. Such results have frequently passed under my notice, but I need hardly say that more scientific treatment will consist in a judicious combination of mechanical and constitutional means.

In the more severe cases of lateral curvature of long standing, when the heart becomes displaced, and to some extent, perhaps, embarrassed by the contraction and deformity of the chest, palpitation, with some irregularity in its action, may become a more prominent symptom and lead to the suspicion of the existence of disease. Many cases, indeed, are recorded in which positive opinions to this effect have been given, but proved to be erroneous. Mr. John Shaw relates two instances of this kind, in "patients who were supposed to be dying of disease of the heart," and in a foot note observes, "since the above was written, I have been consulted by several patients, who had been treated for disease of the heart, though all the symptoms were caused by distortion of the spine."*

Within my own experience I have not met with any such error of diagnosis, and the liability to its occurrence must be

* *Op. cit.*, page 146.

much less than it was in the days of John Bell ; but still I have known several patients, about the middle period of life, afflicted with severe spinal curvature, so impressed with the idea that they were suffering from disease of the heart, that the highest medical authorities failed to remove such impression.

The effects of spinal curvature and distortion of the chest upon the lungs, in cases of severe distortion, are obviously to impede free respiration, so that many patients suffer from shortness of breath, and a sense of oppression at the chest, which incapacitates them for any active exertion, such as quick walking, especially up-hill.

I have now under my care a lady, between forty and fifty years of age, with a rather severe form of lateral curvature, and depression of the left side of the chest ; but she has always enjoyed good health, and been of very active habits till within the last few years, when the spinal curvature and distortion of the chest have increased, and she has gradually become less able to take active exercise, especially walking up-hill, in consequence of embarrassed respiration. She consulted several physicians, who pronounced the heart and lungs to be essentially free from disease, though impeded in their action by the distortion of the chest. Mechanical support was recommended in this case, and not only have these symptoms diminished by the use of a firm spinal support, but considerable improvement in the spinal curvature has been effected.

Many similar cases, and several in which the symptoms referable to the interference with the functions both of the heart and lungs have been much more severe, have been under my observation in hospital and private practice. Amongst the poor, patients beyond the middle period of life suffering from severe spinal curvature are often reduced to a very pitiable condition, and after a time they disappear from our observation, probably to die in workhouses. Still it is equally true that we sometimes see patients with the most severe forms of spinal distortion, who up to the middle period of life have suffered marvellously little, and such cases are sometimes appealed to in support of the opinion that, except in the deformity to which the patients have

already become accustomed, the inconveniencies or sufferings are not considerable at, or after the middle period of life ; but the contrary is well known to be the fact by those who have the opportunity of seeing these cases on a larger scale.

How far the distortion of the chest contributes to the production of any positive disease of the lungs, I am unable to state, but Bouvier is probably correct in his opinion that individuals thus affected rarely live to old age, and fall victims either to phthisis or heart disease.* Next let us consider briefly what are

The effects of Distortion of the Spine and Chest in producing Functional Derangement of the Abdominal Organs.

I refer more especially to the liver, stomach and intestines. The disturbance of the uterine functions will be described as being associated with, but not directly dependent upon, the spinal curvature. The more movable abdominal organs, more especially the stomach and bowels, so readily adapt themselves to any alteration in the form of their containing cavity, that except in the most severe cases of spinal distortion, they can hardly be interfered with mechanically by pressure ; nevertheless functional derangement of these organs very frequently accompanies spinal curvature, and though in some instances it is probably due to the condition of the general health, independently of the curvature, yet in other cases it undoubtedly depends upon the general debility and enfeebled condition of the health, which is directly produced by the spinal curvature, especially where spinal pain is a prominent symptom, as it frequently is, in cases of rapidly increasing curvature, in growing girls between the ages of twelve and sixteen.

Functional derangement of the stomach and bowels frequently depends upon functional disturbance of the liver, which is more directly exposed to mechanical pressure. I have already described the liver as becoming much altered in form, in some cases from tight lacing, and in others from the

* *Op. cit.*, page 683.

depressed and mis-shapen ribs, which in severe cases of spinal curvature are directed obliquely downwards towards the abdominal cavity.

Practically, we know that patients afflicted with spinal curvature frequently suffer from indigestion, with pain at the stomach, loss of appetite, sickness, and in cases of severe curvature, vomiting is sometimes a troublesome and even alarming symptom.

In the year 1854, a lady aged twenty-three, who suffered

FIG. 32.



Case of severe lateral curvature in which the most urgent symptoms were referable to functional disturbance of the liver and stomach. From a lady aged 23.

from a severe form of lateral curvature, came under my care. The curvature involved the whole of the dorsal, and part of the lumbar region, and the chest was much deformed, as represented in Fig. 32; the lower ribs of the left side being much depressed, and sinking into the abdominal cavity. This lady has been a great sufferer from derangement of the liver and stomach, producing severe bilious attacks, often with distressing and long continued vomiting; and these attacks recurred frequently at intervals of about a fortnight,

but sometimes the intervals were longer. She also suffered from severe spinal pain, and frequently from diffused pain over the abdomen.

Great improvement has been effected in the spinal curvature (as exhibited in Fig. 33) by wearing a strong spinal support for several years, and her general health and strength have also much improved, but is still liable occasionally to suffer from derangement of the liver and stomach.

FIG. 33.



Drawing from same case as Fig. 32, after several years' mechanical treatment, showing great improvement of the spinal curvature and general form of the body.

In many instances, obstinate constipation exists, whilst in others the bowels are irritable, and the patient is liable to attacks of diarrhoea and colic. Several cases in which great irritability of the stomach has been a prominent and distressing symptom, have been under my care. One lady in the written account of her case which she sent me observes: "I have often been sick five and six times a day, during the space of a week or more at a time." In other instances the sensation of sickness after taking food has been such as to prevent the

patient taking a sufficient amount of nourishment, and general emaciation has been the result.

The *liver*, as I have already observed, is more exposed to direct mechanical pressure; and functional derangement of this organ frequently occurs in cases of spinal curvature. I had a lady under my care who suffered from severe bilious attacks at intervals of a few weeks; and in another case I examined after death, the gall bladder was found filled with gall-stones. These constantly recurring bilious attacks, and the medicines commonly resorted to for their relief, both by physicians and patients, materially tend to impair the general health.

Next to the effects of lateral curvature in producing functional derangement of the thoracic and abdominal organs, which may be more or less affected by mechanical pressure, I will briefly advert to another series of symptoms, some of which are frequently present, and seriously affect the general health of the patient. The symptoms I allude to are referable either to structural changes occurring at the seat of curvature, or to functional disturbances of the spinal nerves, or of the spinal cord. These symptoms may be described under the three following heads, viz.:

Spinal Pain, Spasms, and Partial Paralysis of the Lower Extremities.

Spinal pain, by which I mean pain referred to the region of the spine, occurs frequently as a symptom of lateral curvature both in slight and severe cases. When it exists in slight cases I regard it as a fortunate circumstance, because attention is at once directed to the spinal affection, and the patient placed under treatment in time for a cure to be effected; but when pain is absent, and there are no other symptoms affecting the general health, as sometimes occurs in lateral curvature, the spinal distortion is allowed to proceed to an incurable stage before any advice is sought. With such absence of pain and other symptoms, it may also happen that the external deformity is so slight as scarcely to attract attention when the girl is dressed, even though the spinal distortion exists in a marked degree.

Spinal pain is by no means a constant symptom of lateral curvature, nor do I recognise any general rule as to its presence or absence in any special class of cases, or any particular form of curvature; but when it does occur, it adds very much to the distress of the patient, by producing a sensation of sickness and sometimes fainting, and often seriously affects the general health, which is sometimes still further impaired by the remedies adopted for relief. Hot brandy and water is frequently resorted to by some sufferers, whilst others habitually take opium; a second dose of opium taken for the relief of spinal pain at night, after the accustomed dose had failed to give the usual relief, was the cause of death in the case of Dr. Mantell. These remedies are constantly resorted to by ladies without medical advice, but to a moderate extent we are obliged to sanction them when other means fail to give the necessary relief. A lengthened experience in private practice can alone make the surgeon familiar with the amount of real suffering, as well as mental distress, entailed upon the patient in many cases of lateral curvature of the spine in its later stages; and yet in the early stages of this affection, when it is undoubtedly curable by simple means, it is generally regarded as an unimportant affection, one which the patient by moderate care and attention to the general health will grow out of.

Spinal pain in cases of lateral curvature may be either *diffused* or *local*, *i.e.*, it may either be diffused over the region of the spine in its entire length, or over the dorsal or lumbar region of the spine; or it may be localized to a particular spot in the neighbourhood of the spine or ribs.

When *diffused* the patient complains of a dull, aching pain in the back, with a sense of great weakness, worse in the erect or sitting position, and always aggravated by walking or other exercise, so that the patient abstains from all exertion; but the pain is not removed by lying down, though it is generally much diminished. In a few exceptional cases I have known the pain to be worse in the night-time, causing the patient to wake with an acute pain, for which various remedies were obliged to be resorted to. Externally the skin over the

spine is so morbidly sensitive, that the patient shrinks from the slightest pressure; even passing the finger lightly down the spine over the spinous processes gives pain. It is said by those who consider this pain to be entirely hysterical, that a firm and continuous pressure can be borne, but it has not been so in the cases in which I have tried it.

The cause of this diffused spinal pain is certainly obscure. In many cases it is undoubtedly associated with hysterical symptoms, and then the hysterical explanation at once appears to be sufficient; but in at least an equal number of cases no other indications of hysteria exist, and we meet with it in patients at all ages up to fifty or sixty. It is commonly spoken of as spinal irritation, and we should certainly expect that irritation and pain at least would result from the twisted condition of the spinal column, with a corresponding alteration in the axis or twisted condition of the spinal cord.

In some rare and exceptional instances spinal pain is associated with a true inflammatory condition. A few years ago I assisted my late colleague, Mr. Lonsdale, to make the post-mortem examination of a young lady who had been some time under his care, and had suffered from diffused spinal pain, which was considered by the late Dr. Roots and other physicians, who had seen the case in consultation with Mr. Lonsdale, to be essentially hysterical. This opinion was held till within three or four weeks of the young lady's death, which was preceded by complete paralysis of the lower extremities, and other symptoms clearly indicating disease of the spinal cord. At the post-mortem examination we found inflammatory effusion with supperation extending a considerable distance along the cord and membranes, with softening of the substance of the cord itself. Such cases, though rare, must lead us to be careful in our diagnosis as to the cause of pain, when we meet with it in the more severe cases.

When *local* spinal pain exists in cases of lateral curvature it is referred to some spot in the neighbourhood of the spine, but not constantly either to the side of the convexity or the concavity of the curve; more frequently, however, the pain is

referred to the side of the convexity, and when this is to the right—its most usual direction—in the dorsal region, the pain is generally referred to a part a little below the angle of the scapula; and in the lumbar region, the convexity of the curve being generally to the left, a very acute pain is frequently referred to about the position of the transverse processes. These processes being altered in their transversity by the movement of rotation previously described, project towards the skin, and push outwards the lumbar mass of muscles along the convexity of the curve, so as to form an external prominence in this situation, which, as I have already mentioned, has been repeatedly mistaken for abscess, the muscular swelling giving a doubtful sense of fluctuation.

In many cases under my care the acute pain at this particular spot, always increased by motion and by the erect or sitting position, and relieved, but not removed, by lying down, has been the most distressing symptom of the spinal curvature; and for the relief of this pain alone advice is frequently sought in many adult cases, when the patient has no hope of any improvement being effected in the distortion of the spine.

The case represented in Figs. 34 and 35 affords a good illustration of this point. This lady, aged twenty-four, came under my care in the year 1854, suffering at that time from an amount of pain in the lumbar region, which prevented her from either walking, or being able to sit upright, and affected the general health. The curvature was said to have commenced at the age of sixteen, and various plans of treatment had been adopted. She had, at an early period, been kept lying down for two years by the late Sir B. Brodie, and, subsequently, spinal instruments had been worn, but these were of bad construction and inefficient. Latterly all supports had been discontinued, and horse exercise recommended, which, in a marked degree, had contributed to increase of curvature in the lumbar region and production of pain, for which I was first consulted.

By a combination of mechanical treatment and partial

recumbency, great improvement was gradually effected, and the pain removed. This was the first case in which I applied the principle of the *rotation plate* I continued to use for many years in severe cases.

Local pain is sometimes complained of over two or three spinous processes, generally in the middle or lower dorsal region, and this may be so marked as to induce the surgeon to suspect the existence of actual disease of the spine at this part, a complication which occurs only as a rare and exceptionable

FIG. 34.



Case of double lateral curvature with considerable rotation of the lumbar vertebrae, and projection of spinal muscles on the left side, which was the seat of an unusual amount of pain. From a lady, aged 34, in whom the curvature was said to have commenced at the age of 16 years.

event. Generally, the existence of this local pain over a few spinous processes need not give rise to additional anxiety, but may be regarded either as connected with an hysterical condition, or some local changes taking place during the increase of the spinal curvature.

In other cases, and these are not uncommon, local pain exists in the lower part of the lumbar region and over the sacrum.

This pain generally co-exists with some marked disturbance of the uterine functions, with which it has appeared to me to be directly connected: or else with some unhealthy condition of the rectum, the patient having suffered for some years from hæmorrhoids.

Local pain in some cases of spinal curvature also occurs at a distance from the spine, but is then traceable to some changes in direction and altered relations of the ribs, which, in

FIG. 35.



Drawing from same case as Fig. 34, after two years' mechanical treatment, showing improvement in the spinal curvature, and diminution of the prominence in the lumbar region.

severe cases rub against and sometimes overlap each other in the concavity of the curve. The depressed ribs, in some cases described as *large single curves*, dip into the pelvic cavity (as they did in the case represented in Fig. 42), and produce pain, either by rubbing against the soft parts over the crest of the ilium—a part at which pain is frequently complained of—or by irritating some of the nerves which traverse the pelvic

cavity, when a deep-seated pain is complained of in the pelvis.

The *cause of the local pain*, or of the pain when localized in particular spots may, I think, in all cases be satisfactorily traced to some of the local changes already described as taking place in the various structures of the spine during the formation and increase of the curvature; and, as a general rule, the existence or increase of the pain corresponds with an appreciable increase of the curvature, at whatever period of life this may take place.

By some authorities on lateral curvature the local pain has been supposed to depend upon extension, or stretching of the intervertebral and costo-vertebral ligaments, and irregular tension of the intercostal muscles. Mr. Brodhurst holds this opinion, but to me this explanation appears to be unsatisfactory. As far as my observation has extended, local pain has generally been absent in those cases in which an increased extent of flexibility undoubtedly existed, and in which, therefore, stretching of ligaments and muscles might well be supposed to take place; whilst on the other hand, the worst cases of local pain which have come under my observation—cases in which this has been the most urgent and distressing symptom, and for the relief of which advice was especially sought—have been in the most rigid and least flexible forms of spinal curvature (as shown in Figs. 34 and 36), generally of many years' duration, but slowly and progressively increasing. The patients have been between the ages of twenty and forty, except in those instances where the pain obviously depended upon some of the abnormal conditions of the ribs, above adverted to, and many of these patients have been much older. The lady, whose case is represented in Fig. 42, was sixty-five years of age.

In these severe and rigid cases in adults, it has appeared to me that the local pain has depended upon direct mechanical pressure on parts not adapted to receive pressure; and if we consider the various structural changes which necessarily occur in every severe case of lateral curvature, the existence of local pain, if not

satisfactorily explained by reference to the changes in any particular structure, at least can no longer be matter of surprise.

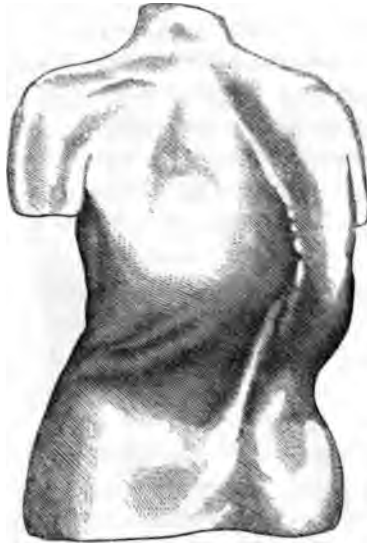
I have already shown that not only the bodies of the vertebræ and intervertebral cartilages become wedge-shaped, but the oblique articular processes are much altered in shape and direction, and also become nodulated by deposit of bone at the margins of the articular facets, much in the same way as the articular extremities of the bones become enlarged in what is termed "chronic rheumatic arthritis." The transverse processes, especially in the lumbar region when the curvature is severe, also become altered in shape and direction, being either twisted upwards or outwards in a horn-like fashion, as usually occurs in the transverse processes of the upper lumbar vertebræ; or compressed and flattened transversely, as we found the transverse processes of the fourth and fifth lumbar vertebræ in a specimen represented in Plates III., IV. and V., and in which these processes rested upon, and, in a manner, articulated with, the crest of the ilium. Such changes must necessarily be accompanied with more or less local pain.

It might perhaps be supposed that the severe local pain was at least in some instances produced by direct pressure upon the spinal nerves as they emerge from the spinal canal; but I have not been able to satisfy myself that such pressure ever occurs. Anatomically, we know that the foramina through which the nerves pass out from the spinal canal are of large size, as compared with the nerves which pass through them, and Mr. John Shaw tells us that upon dissection he has found the nerves on the concave side of the curve, "diminished to less than one half their natural size," not from pressure, but in consequence of the atrophy of the muscles in the concavity of the curve. This fact is mentioned as evidence opposed to the opinion that lateral curvature is produced by increased muscular action, which would pre-suppose a condition of hypertrophy rather than atrophy of the muscles in the concavity of the curve. Moreover, if direct pressure on the spinal nerves were the cause of the local pain, the seat of pain ought certainly to be in the concavity of the curve, whereas the

reverse is undoubtedly the case; and in the worst forms of curvature in the lumbar region the pain is generally referred to the convexity of the curve.

A case very similar to that represented in Plates III., IV. and V., is shown in Fig. 36. The distortion in this case, involving the lower dorsal and lumbar vertebræ, occurred in a gentleman aged twenty, and had increased rapidly during three years. The pain was so severe as to prevent him from maintaining the sitting position for any length of time, and therefore incapacitated him from completing his studies at

FIG. 36.



Case of severe spinal curvature with sharp rotation of vertebræ in the lower dorsal and lumbar regions, accompanied with severe pain and loss of health. From a gentleman, aged 20 years, and 5 feet 10 inches in height.

Oxford. His general health was also much impaired. By wearing a spinal support, combined with lying down for six hours a day, the curvature has greatly diminished, as shown in Fig. 37. The general health has proportionably improved, and the spinal pain has much diminished, though not completely removed.

It is not my intention at present to discuss the principles of treatment applicable to the different cases of lateral curvature, or to consider whether any special indications are derived from the existence of pain, either in its diffused or local form; but I have no hesitation in stating that the severe treatment, such as cupping, the application of blisters, moxas, &c., to which I have known many patients suffering from spinal pain in one or other of its forms to have been subjected, is totally unnecessary, and calculated only to exhaust the powers of the patient and aggravate the spinal affection.

FIG. 37.



Drawing from same case as Fig 36, showing diminution in the spinal curvature and general improvement in form, after two years' mechanical treatment.

No good can possibly result from such treatment, the adoption of which, indeed, implies erroneous views of the nature of the pathological changes in progress. I will merely mention that the remedies upon which I rely for the relief of spinal pain are, the application of a belladonna plaster, or of a liniment of aconite and belladonna, or of the tincture of iodine to the spine, and the use of a strong and well-adjusted spinal

instrument. The use of firm mechanical support, as a means of relieving pain in cases of spinal curvature, is undoubtedly of great value.

In the case of growing girls who suffer from the diffused pain in the spine above described, the relief afforded by wearing a spinal instrument is generally rapid and certain, and is always followed by improvement of the general health, as well as of the spinal curvature. In severe adult cases, accompanied with local pain, a similar result as to the relief of pain generally follows, so that we resort with confidence to the use of mechanical support for this purpose, even when we do not look for, and the patient does not expect, much improvement in the spinal curvature. Nevertheless, when increase of the curvature has recently taken place, positive improvement in form will be obtained, even at an advanced period of life; a good example of which is afforded by the case represented in Figs. 38 and 39.

LECTURE VIII.

LATERAL CURVATURE OF THE SPINE;—GENERAL PATHOLOGY (CONTINUED)—SYMPTOMS;—COMPLICATIONS;—AND NATURAL HISTORY.

I WILL now briefly advert to another symptom which I have alluded to, as occasionally occurring in cases of lateral curvature, viz., spasms.

Spasmodic pains, of a very severe and even alarming nature, sometimes occur in cases of lateral curvature, but of their cause and mode of production, I am unable to give any satisfactory explanation. In one case, that of a lady aged thirty-nine, who suffered from severe lateral curvature to the left side, the symptoms which caused the greatest anxiety were prolonged fainting fits and attacks of severe spasmodic pains. My friend, the late Dr. R. Goolden, who attended this patient, described these attacks as spasms of the diaphragm, and on several occasions thought she would sink from the interference with respiration and exhaustion.

This lady died three years after I first saw her of rapid consumption. At the post-mortem examination I found the gall-bladder filled with gall-stones, and at first thought the spasmodic attacks might have been connected with the passage of gall-stones, but Dr. Goolden considered the attacks of spasm were certainly not referable to this cause; moreover, she first became subject to these severe spasmodic seizures at the age of seventeen years, and it is not likely that she suffered

from gall-stones at that age. The cause, therefore, remains obscure, as no light was thrown upon the symptoms by the post-mortem examination.

The form of curvature in this case, was that of a long single curve, involving the whole of the dorsal and some of the lumbar vertebræ, the convexity of the curve being to the left side, as shown in Fig. 38. It had formed gradually from about

FIG. 38.



Case of severe lateral curvature involving the whole of the dorsal and some of the lumbar vertebræ, with the convexity to the left side, accompanied by unusually severe symptoms, in a lady aged 39.

the age of twelve years, and had been produced by sitting and walking badly, in consequence of a paralytic condition of both legs, which required mechanical support. This lady was, at the age of five years, the subject of paralysis affecting both arms and both legs, and probably involving to some extent the muscles of the spine and trunk. The arms recovered perfectly, but the paralysis of the legs remained through life with but little improvement, and from the year 1830 to 1852, when I first saw her, a period of twenty-two years, she had not been

able to walk, even with any amount of mechanical assistance that could be rendered her.

At the age of seventeen years, when spinal curvature was no doubt progressing, she became subject to fainting fits, often remaining insensible for an hour and a half or two hours, and soon afterwards she was seized with the severe spasmodic attacks described. As this lady was so crippled as only to move about the room in a wheel-chair, and no hope being

FIG. 39.



Drawing from same case showing improvement after two years' mechanical treatment, by which all the symptoms were removed.

entertained that she would ever be able to walk, the treatment recommended was reclining, and at one time the plan of extension by weights from the head was tried, but without any benefit, the apparatus represented in Fig. 45 being employed. I commenced the treatment of this case by removing the contractions of the feet, which was accomplished in three month by tenotomy and mechanical means. She was then enabled to walk with the aid of steel supports extending above

the knee joints, and could soon afterwards go up and down stairs with a little assistance.

It then became necessary to support, and endeavour to improve, the increasing curvature of the spine; all the urgent symptoms to which she was subject, viz.: severe spinal pain, fainting fits, and spasmodic attacks, were completely removed by the use of the spinal instrument which she wore during the last three years of her life, and the spinal curvature was also much improved, as shown in Fig. 39. She died in May, 1855, aged forty-two, of rapid consumption, which appeared to commence only six months before her death.

Another case was that of a lady, aged twenty-nine, whom I attended in conjunction with Mr. Bury, of Whetsone, in November, 1859. She was tall, muscular, of ruddy complexion and healthy appearance, but had for many years been the subject of slight lateral curvature to the right side in the middle and lower dorsal regions, which had rapidly increased during the last two years. She had been confined to the bed or sofa for six months, and only able to walk a little for six months before I saw her. She suffered from very severe attacks of spasmodic pain in the direction of the diaphragm, and these would recur frequently at short intervals during a week or two, and then she would remain free from them for several weeks. She also constantly suffered from diffused spinal pain, aggravated by exertion.

All the symptoms from which this lady suffered were completely removed by the use of a strong spinal support, combined with partial recumbency and the exhibition of tonics. The relief was slowly effected, and for two years she occasionally suffered from severe spasmodic attacks, but is now (1865) completely cured, having left off all mechanical support for nearly a year, and the general result of the case has been most satisfactory.

Another very formidable symptom which we sometimes meet with in cases of lateral curvature of the spine, is

Partial paralysis of the lower extremities; and associated with this condition we occasionally find some deformities of the feet,

such as talipes equinus, or equino-varus, and less frequently contraction of the knees and hips.

The cases to which I refer might well be grouped together, and described as a separate class, from the peculiarities which they present, and which are always obscure, but appear to belong essentially to the class of hysterical contractions.

These cases are generally met with in women between the ages of twenty and forty, and are described to us as instances of bed-ridden women who have lost the use of their legs for several years—from five to ten years, perhaps, but in one case, which came under my observation, it was nineteen years—and they are supposed to be suffering from obscure spinal affection. They do not generally complain of any particular pain, or suffer from other urgent symptoms, such as spasms, &c., though liable to various functional derangements; but these patients are unable to stand, and hence are confined either to the sofa or the bed, and frequently are unable even to sit upright.

Upon examination we do not discover any evidence of the existence of actual disease of the spinal column,—*i.e.*, of the bones of the spine—nor of any disease of the spinal cord; we find only a simple curvature of the spine, essentially lateral, and of the form described as a long single curve, rather than a well marked double curve; but generally there is also considerable posterior curvature, which has probably been produced by the patient being habitually propped up in bed by pillows in a half sitting position.

The spine is frequently found so weak and flexible that it will curve in any direction, and by moderate pressure the posterior curvature is easily overcome. A fixed lateral curvature in the lumbar and lower dorsal regions more frequently remains, and viewed in connection with some peculiar constitutional condition,—in many cases essentially hysterical,—appears to be the only explanation of the partial paralysis of the lower extremities.

We are all familiar with the fact that the closest resemblance to actual disease, almost of any organ of the body, is frequently met with in women of a highly nervous temperament and

hysterical constitution ; and that in the discrimination between actual diseases and hysterical affections simulating diseases, the skill of the most experienced physicians and surgeons has frequently been baffled, and this fact must be borne in mind when examining any of the cases to which I am now directing your attention.

In these patients the feet are contracted in the form of talipes equinus, or equino-varus, the deformity being in all respects similar to that frequently met with, without the existence of any spinal curvature, and clearly traceable to some morbid condition either of the nerve trunks or of the nerve centres.

Some morbid condition of the spinal cord might be suggested as a cause of this partial paralysis, but this has not been satisfactorily proved. In Sir Charles Bell's "Practical Essays," Note 6 by Mr. A. Shaw,* "On the state of the spinal cord" in lateral curvature of the spine, it is observed: "During the changes described in the text, this organ undergoes an incurvation and a twisting of its substance in a spiral direction, corresponding with the distortion of the spine. Now, an accommodation *in* the shape of the cord of such a kind cannot be effected without certain portions suffering, to a greater or less degree, from the same processes of absorption which act upon the vertebræ and other structures." There can be no doubt that in severe cases of distortion, a spiral twisting and lateral bending of the spinal cord must exist, but that this would be sufficient to explain the symptoms above described, may be doubtful.

The local and general treatment in this class of cases ;—severe counter-irritation such as moxas, seatons, issues, large and repeated blistering, &c., are decidedly injurious, as it exhausts the general health without benefitting the disease ; the same may be said of cupping. I have met with several cases in which cupping had been resorted to, the marks of the scarificators being visible down the entire length of the spinal column, without giving relief to the pain, whilst the general

* *Op. cit.* page 159.

health had been damaged to a serious extent. In many of these cases that have come under my notice, this treatment has been adopted on the Continent.

Absolute rest and lying down are still extensively resorted to in England, but I have seen considerable injury to the general health result from this treatment; and one of the most serious results is, that patients ordered to lie down for a few months, cannot be induced to get up again; they continue either in bed or on the sofa for several years, and then only by perseverance in the use of a firm mechanical support, are they enabled gradually to resume the erect position, and slowly recover the power of walking.

At the hospital I had under my care a woman who had been seven years lying down, after wearing a support for about six months she was enabled to walk, and in a short time was discharged cured.

In another case under my care the patient had been nine years lying down; and in another more remarkable instance the patient, a woman, aged twenty nine, had been nineteen years lying down. This woman had a general yielding of the whole spinal column, with such an amount of muscular debility, that she was totally unable to support herself in the sitting position, and in the lower dorsal and lumbar region there was a permanent curvature, but not to any severe extent. In this case there were hysterical blindness and permanent contraction of both feet, so that my late colleague, Mr. Lonsdale, and myself agreed on the propriety of dividing the Achilles tendons. This woman wore a strong spinal support, and remained in the hospital nearly two years, when she was discharged able to walk about without any mechanical assistance, and I was afterwards informed she went to Australia and married. The blindness had almost disappeared. Some time after she left the hospital I saw her in the streets walking so well, that I thought I must be mistaken in the identity, but following her quickly I spoke to her, and was astonished to find that she exhibited scarcely any trace of her former affection.

In another still more severe case than the latter—but one of the same class, and now under the care of my friend, Dr. Cleveland, of Maida Hill—the spinal curvature is very severe, contraction of the hip and knee-joints has taken place, and from the excessive prostration of the patient and inability to wear any spinal support, I see no prospect of this woman recovering; it is only matter of surprise that she has continued from year to year in this condition, and is still living (1881).

There can be no doubt that in many instances these cases admit of most effectual relief. I do not use the word *cure*, although the relief afforded is practically as complete as that implied by the word. The treatment may be either entirely mechanical, or operative and mechanical combined; and in a few months these patients are sometimes enabled to walk and resume the ordinary pleasures and duties of life.

We have now passed in review the local and general symptoms of lateral curvature of the spine, and amongst the latter I have included various conditions depending either upon the mechanical effects of the curvature in producing pressure upon the thoracic and abdominal organs; or upon some local changes taking place in the articular surfaces, the result of irregular mechanical pressure, such as would give rise to pain; or upon some interference with the nerves, or nerve-centres, which would produce various spasmodic and paralytic complications.

Next, I will briefly advert to some conditions, which though not depending upon the spinal curvature, are nevertheless, frequently found associated with it, and therefore demand our attentive consideration in the treatment of these cases. The conditions to which I refer may be best discussed by considering

The Connection of Lateral Curvature of the Spine, with Disturbance of the Uterine Functions, Hysteria, and Consumption.

The uterine functions are frequently disturbed in one class of cases, viz., those which occur in growing girls, between the ages of twelve and sixteen; and this functional derangement is

generally associated with muscular debility, an enfeebled condition of the general health. In such cases the natural periods are irregular, sometimes arrested; but more frequently the loss is excessive, and at once affords sufficient explanation of the general exhaustion, with a disposition to fainting, &c., which sometimes occurs.

The effects upon the general health are such as we meet with in other cases in which there is no spinal curvature; but when the two conditions are associated, each one reacts prejudicially upon the other, and therefore the uterine complications ought to be carefully attended to, and if possible removed, at the same time that the special treatment for the spinal curvature is being carried out.

Hysteria is also one of the most frequent complications of spinal curvature, leading to an exaggeration of the general symptoms already described, especially of the spinal pain, and various functional disturbances. To this cause we must attribute in a greater or less degree some of the paralytic affections of the legs to which I have just adverted. A more unsatisfactory and unmanageable complication it is impossible to meet with, and as in these cases the hysteria is superadded to other affections which, in themselves, are a sufficient cause of pain, such as loss of health, and functional disturbances, it is often impossible to come to any satisfactory conclusion as to how much depends upon the spinal affection, and how much upon the hysterical complication.

Nevertheless, in practice these complications are often found to diminish steadily, and sometimes to disappear, as the general health improves under the treatment adopted for the spinal curvature.

Consumption, or perhaps it would be more correct to say a *consumptive tendency*, frequently exists as a complication of lateral curvature of the spine. I have directed your attention to the constitutional origin of lateral curvature, and the classification of cases which I have adopted is based very much upon the relative degrees in which the constitutional and local causes combine to the production of curvature at different

periods of life. I mentioned the frequency with which we traced the hereditary tendency to lateral curvature; and in these cases, also, we commonly find a consumptive family history.

In private practice I have had many young ladies with lateral curvature under my care whose mothers have died of consumption, after suffering from lateral curvature; and frequently we have a history of consumption extending through two or three generations.

The patients themselves, in their general conformation and appearance, present the ordinary indications of consumptive tendency; but at the early age at which lateral curvature occurs, usually under twelve years of age, there are no chest symptoms indicating the existence of tubercle. A little later, however, between the ages of sixteen and twenty, these symptoms sometimes appear; but the cases which I have seen in advanced consumption have generally been at a much later period, either between thirty and forty years of age, or even later.

A lady, aged forty-two, in whom a most severe form of curvature to the left side existed, as shown in Fig. 38, and who had been three years under my care, died of rapid consumption in May, 1855. My friend, Dr. Allen, of St. John's Wood, assisted me to make the post-mortem examination.

The right lung (situated in the concavity of the curve), exhibited large tubercular cavities in its upper part, and the lower lobe was infiltrated with tubercular deposit in a softened condition. Masses of crude tubercle and a small cavity existed in the left lung, but a considerable portion of this lung was in a healthy condition, and must have served the purposes of life. Dr. C. J. B. Williams, who attended this lady in her last illness, and had correctly diagnosed these conditions, informed me that they corresponded to other cases which had fallen under his observation.

At the post-mortem examination of the case, represented in Plate II., I found old tubercular deposits in the apices of both

lungs, showing arrest of tubercular disease in early life. This patient died of cancer of the breast and internal organs.

I have alluded to the case of a lady, who died of tubercular disease at the age of sixty-two years. Her health had failed, and the chest symptoms appeared after forty years of age; and from forty to sixty the spinal curvature had steadily increased, so that a spinal support had to be worn for about three years previous to death.

In several cases under my care, in which consumption has been clearly evidenced, between the ages of twenty and thirty, all idea of advantage from spinal treatment, except that of a stay-support with steel crutches, had been abandoned; these cases I have since lost sight of, but the consumptive symptoms were sufficiently well marked to indicate a fatal termination from the disease.

Without being able to prove the fact by statistics, which I think it would be impossible for anybody to obtain, I entertain no doubt from my own observation and experience, that death by consumption is a common event in cases of lateral curvature.

The experience of physicians who have the largest practice in chest affections, and those attached to the Consumption Hospital, might at first sight appear to be opposed to this opinion; because it has been remarked by them that they rarely meet with spinal curvature, or deformity of the chest, in the cases of consumption which pass under their observation. But when it is remembered that consumption is the commonest disease of this country, so that every medical practitioner witnesses many deaths from this cause every year; and if it be also remembered that lateral curvature of the spine is, as compared with consumption, a very rare affection, so that each practitioner sees only a few cases even in the course of a long experience, it will at once be seen that the opinions above expressed are not really opposed to each other, or in any way incompatible.

Before entering upon the question of treatment, it will be useful to glance at a few points in the

Natural History of Lateral Curvature; its Progress and Terminations; the supposed influence of the completion of growth in arresting the Progress of Curvature; and the liability to increase at Late Periods of Life.

It is impossible to estimate too highly the importance of studying the natural progress of any disease as it pursues its course, when not interfered with by medical art; to observe on the one hand the various processes which lead to an unfavourable termination—involving either the destruction of the part or the death of the patient;—and on the other hand, to study carefully the curative powers of nature, by which complete restoration may be accomplished, or the progress of disease arrested.

Failing in either of these results, then, with a watchful eye, we observe how the injurious effects of disease are, by a natural effort, diminished by various compensative processes, which by their perfection and evidence of design, have at all times excited the admiration of philosophical observers, and afford the medical practitioner a scientific insight into the principles by which he should be guided in the exercise of his art.

To assist in the completion of these curative or compensative efforts of nature, must then be the object always in view, and a knowledge of the way in which nature works towards the accomplishment of these ends, can be the only reliable basis for determining the principles of treatment.

It appears to be too generally assumed by authors on lateral curvature of the spine, that unless the curvature be cured or arrested by treatment, it must necessarily increase, and proceed not only to the production of conspicuous deformity, but to the more serious ruin of the general health. That such is frequently the termination of lateral curvature we have daily opportunities of witnessing; but that its natural progress must necessarily lead to such a result, is an erroneous assumption which we have also many opportunities of disproving.

There can be no doubt that the increase of a curvature of the

spine may be, and frequently is, completely and permanently arrested by the production of compensating curves in different parts of the spinal column.

This spontaneous arrest very commonly takes place in cases of slight curvature; ladies are often seen at the middle period of life, who for many years have had a curvature of the spine, but never suffered from any of the symptoms which generally accompany this affection, nor has attention been directed to the condition of the spine. They imagine nearly all the ladies they know have something of the same kind, and especially regard the prominence of the shoulder as almost a natural condition; moreover, when they see the same defects in symmetry appearing in their daughters, they regard them with indifference, and appealing to the same conditions in themselves, oppose the necessity of any treatment being adopted.

These cases, however, are undoubtedly examples of spontaneous arrest of spinal curvature in the early stage, and I now exhibit to you the spinal column with portions of the ribs attached (represented in Plate II.) which I removed from one of these cases.

The woman was thirty-seven years of age, and although the external deformity was so slight as not to attract attention whilst she was in the hospital, yet internally a well-marked double curvature was apparent, as represented in Fig. 2, Plate II., and a close inspection will show that in the perfection of the compensative process, two other small curves had been formed in the length of the spinal column, so that in four places one or more vertebræ are compressed and a little diminished in thickness, at the part corresponding to the concavity in four different curvatures, indicated by the letters *a, a, a, a*. It is impossible to conceive a more perfect example of spontaneous arrest of slight spinal curvature.

This woman died of cancer of the left breast and internal organs, and in the uterus were two fibrous tumours. In the apices of both lungs were old encysted tubercular deposits, proving that a tubercular diathesis existed in early life; but the increase

of tubercular deposit had been arrested, though only to make way for a more formidable and equally fatal disease.

Another good illustration of spontaneous arrest in a case of double lateral curvature, where the curves in the dorsal and

FIG. 40.



Portion of an adult female skeleton, showing spontaneous arrest of lateral curvature; the lumbar and dorsal curves being about equal in length.
Posterior aspect, from a photograph.

lumbar regions are about equal in length, is exhibited in a specimen in the Museum of the Middlesex Hospital, No. $\frac{11}{26}$, from which Figs. 40 and 41 have been drawn, with the kind permission of the Museum Committee. This specimen consists of the spinal column, thorax, and pelvis of an adult female

who had been the subject of double lateral curvature of the spine, with the usual characteristics of a dorsal curve to the right and a lumbar curve to the left side, and with corresponding alterations in the shape of the thorax. The curves are about equal in length, and spontaneous arrest has taken place at the

FIG. 41.



From same specimen as Fig. 40, anterior aspect, showing increased deviation of bodies of the vertebræ, but the curves still about equal in length.

adult period of life, in all probability without any treatment having been employed; the specimen, which is a very old one, was most likely obtained from the dissecting-room in the days when those eminent surgeons, the Bells and the Shaws, were

associated with the Middlesex Hospital, and to whose valuable observations I have already so frequently referred.

Whilst I assert that instances of such spontaneous arrest of lateral curvature are by no means of uncommon occurrence, it is equally certain that this result is the exception, and not the rule, and that no reliance can be placed upon the occurrence of so fortunate and desirable a termination.

The conditions most favourable to the production of this spontaneous arrest are; 1st. equality in the length of the curves; 2nd, muscular strength, and a robust condition of the general health; and 3rd, when the curvature is produced at a comparatively late period, say between twelve and sixteen years of age, by local causes acting mechanically, so as to disturb the equilibrium of the body, such as a bad habit of standing, or sitting awry, or by any occupation which necessitates the long continuance of some bad position. From the absence of one or more of these conditions, and most frequently perhaps from inequality in the length of the curves, the lateral deviation when once established steadily and progressively advances to a degree of deformity which is conspicuous externally, and disturbs the symmetrical form of the body.

Liability to increase of lateral curvature at late periods of life.—There is a general opinion amongst the public, which in some degree is also shared by many members of the profession, that the *completion of growth* exerts a powerful influence in arresting the progress of curvature; sometimes it appears even to be considered that there is no liability to increase after the completion of growth, say at the age of twenty-one or twenty-two years; but there is very little foundation for any such opinion. It is true that when a girl is in good health about the age of twenty, and has only a slight degree of lateral curvature, this may remain without increase for a considerable time—and in many cases even during life—but undoubtedly there still remains a liability to increase, which may occur at any period of life.

I have already adverted to the case of a lady I attended in conjunction with Mr. J. M. Burton, of Blackheath. This lady

had a spinal curvature, which up to the age of forty had not been severe enough to produce external deformity; but, in consequence of failure of the general health, produced by the advance of tubercular disease of the lungs, the spinal curvature steadily increased after the age of forty, and at the age of sixty-two, a spinal instrument had to be worn to relieve the pain which, either in the sitting or standing position, was caused by the depressed ribs in the concavity of the curve coming in contact with the crest of the ilium, and dipping

FIG. 42.



Case of severe spinal curvature in which pain was caused by the depressed ribs sinking into the pelvic cavity. The curvature had greatly increased between the ages of 40 and 60, and was associated with phthisis.

into the pelvic cavity, where they probably came in contact with some of the nerves in this region. This case is represented in Fig. 42.

With the assistance of the spinal instrument, which was so arranged as to support the convexity of the curve and raise the depressed ribs, this lady was at once enabled to sit up eight hours a day. She afterwards went to the sea-side, and

derived the greatest comfort from the support, till by the advance of the disease of the lungs, she died about three years afterwards.

Cases in which increase of lateral curvature takes place between the ages of twenty-five and forty, are of frequent occurrence, the cause being traceable in many instances to the debilitating influence of child-bearing, or to some illness; but we also frequently see increase of curvature at the same period of life in strong, muscular, and unmarried women, without any obvious cause, except the inequality in the length of the curves; in some cases the dorsal, and in others the lumbar curve predominates, and in these instances the increase is evidently due to mechanical causes alone.

Such then is the uncertain course pursued by lateral curvature of the spine at different periods of life; and in this uncertainty we see the strongest reason for urging the continuance of systematic treatment at the commencement of the affection, whilst it is yet within our control, and beyond doubt capable either of cure or great improvement during the active period of growth, say from fourteen to seventeen or eighteen years of age.

It remains for me now only to make a few observations on the diagnosis and prognosis of lateral curvature.



LECTURE IX.

LATERAL CURVATURE OF THE SPINE—GENERAL PATHOLOGY (CONTINUED)—DIAGNOSIS AND PROGNOSIS.

The Diagnosis of Lateral Curvature.—To many of you it might appear superfluous that I should say a word about the *diagnosis* of lateral curvature of the spine. You will say, why the thing speaks for itself, you have only to pass your finger down the spinal column, tracing the apices of the spinous processes, and any lateral deviation which may exist will be at once detected; or when the patient stands before you, this deviation will be sufficiently evident, and other defects in the symmetrical form of the chest and shoulders will assist in at once indicating the mischief.

Now, this is undoubtedly true with respect to the great majority of severe, as well as many of the cases which would generally be considered slight; but several slight, and sometimes even severe cases, cannot be detected by such means; and I wish particularly to impress upon you the fact, that to rely upon the external examination of the spinous processes, *i.e.*, whether they are in a straight line, or present any lateral deviation, is a great practical error; and that the relative position of the angles of the ribs in the dorsal, and the transverse processes in the lumbar region, is much more certainly diagnostic than the spinous processes.

The only certain and reliable indication of the existence of lateral curvature of the spine in the dorsal region, is a prominence posteriorly of the angles of the ribs on one side,

and a corresponding depression of the angles of the ribs on the other side; and in the lumbar region, a prominence posteriorly of the apices of the transverse processes on one side, and a corresponding depression of the transverse processes on the other side.

In the dorsal region, corresponding to the posterior projection of the angles of the ribs, *i.e.*, on the convexity of the curve, there is also a prominence of the muscles connected with the scapula, and of the bone itself—a so-called *prominent shoulder*—produced by the altered relations of the ribs. And in the lumbar region, corresponding to the posterior projection of the transverse processes, *i.e.*, on the convexity of the curve, there is a prominence of the spinal muscles, the sacro-lumbalis, and longissimus dorsi, the causes of which I have already explained. (*See Lecture IV.*)

In the lumbar region also, corresponding to the concavity of the curve and the depression of the transverse processes, there is frequently an increased *prominence of the hip*, and this generally occurs on the same side as the prominence of the shoulder, *i.e.*, on the right side. This increased prominence of the hip is apparent, and not real, depending upon the depression, or sinking in of the loin on the same side, caused by the rotation of the lumbar vertebræ.

These may be the only indications of the existence of lateral curvature of the spine affecting the bodies of the vertebræ. There may be no lateral deviation of the apices of the spinous processes, and in slight cases it frequently happens that there is no such lateral deviation. In the case represented in Plate II., the lateral deviation of the apices of the spinous processes is shown to be very slight, and would not have been detected during life; but the lateral deviation of the bodies of the vertebræ, representing the internal curvature of the spine, is shown to be considerable.

I do not regard this case as at all exceptional in its character, but rather as illustrating the ordinary condition existing in the class to which this specimen belonged. The case was evidently one that might be described as an example of slight

double lateral curvature, which had undergone the process of natural or spontaneous arrest without any treatment whatever.

An error of diagnosis in consequence of relying upon the unaltered relative position of the apices of the spinous processes, and especially in the absence of any lateral deviation of these processes, would clearly have been of little or no consequence in a case such as that to which I have just adverted; as little benefit could have resulted from any system of treatment, except absolute recumbency for several years during the period of growth, and the remedy would certainly have been much worse than the disease; but the same error of diagnosis in a case of more severe lumbar curvature, affecting the bodies of the vertebræ, and unaccompanied with any very obvious lateral deviation of the apices of the spinous processes, (a case such as represented in Plates III., IV. and V.), might lead to the most serious results, and, indeed, it is scarcely too much to say that in this case a life of the greatest value to society and to the interest of natural science, was indirectly sacrificed to an error of diagnosis, the repetition of which it is now my endeavour to show you how to avoid.

It is true that the late Dr. Gideon Mantell, who was unfortunately the subject of the case at present referred to, did not die directly from the spinal curvature; but the intense pain he frequently suffered obliged him to resort to the use of opium, and on one occasion having taken a second dose in the night to procure sleep, the symptoms of narcotic poisoning were produced, and a fatal result ensued.

If the existence of the spinal curvature in this case, as shown in Plates III., IV. and V., had been correctly diagnosed, it would certainly have led to treatment calculated to relieve the pain, and a strong mechanical support combined with recumbency for about half the day, together with avoidance of long continued sitting and standing, would probably have removed the pain, without the necessity of resorting to any anodynes.

The swelling which existed in the left lumbar region, and which was proved by the post-mortem examination to have

been produced by the spinal and abdominal muscles being displaced and pushed outwards by the transverse processes of the lumbar vertebræ, conveyed to the touch a sense of fluctuation sufficient to deceive all the eminent medical and surgical authorities who had been consulted in the case, including Liston, Brodie, Bright, Lawrence, Stanley, Coulson, Hodgkin, &c.; so positive were some of the surgical authorities that this tumour was a lumbar abscess, that Liston offered to open it, but this was fortunately delayed. As the tumour did not increase in size and run the ordinary course of lumbar abscesses, but at times seemed rather to diminish, Mr. Stanley told me that he thought the matter was becoming firmer, or concrete, and the abscess altogether inclined to shrink, as abscesses sometimes do, and gradually disappear. The opinion of a lobulated tumour being connected with the bodies of the vertebræ was also held, especially by Dr. Hodgkin.

The simple nature of the swelling—which may certainly be alluded to as an instance of the deceptive sense of fluctuation which muscular tumours are well known to convey to the touch;—the absence of any destructive disease of the spine, such as caries or necrosis which had been feared; and the absence of any morbid growth, &c., were determined, and all the obscurities of the case satisfactorily cleared up by the post-mortem examination, which I conducted in the presence of Dr. Hodgkin, Sir B. Brodie, Dr. Sealand, and others; the request that such an examination should take place having been made by the deceased in a note attached to his will.

It is quite true this may be regarded as an extreme case of its class, representing the maximum of internal curvature, with the minimum of external deviation of the apices of the spinous processes; but in public and private practice I have seen several examples of the same kind, and nearly of the same degree. Many similar cases in which this deviation has existed to a less extent have fallen under my observation, and in one of these I witnessed the same error of diagnosis at the hospital, where one of my junior colleagues offered to open the supposed abscess in the lumbar region. This case was that of

the factory boy referred to in Lecture VII. I took the boy under my care, and by the assistance of a mechanical support, and discontinuing his occupation, he steadily improved; but the curvature was too severe to be curable.

It should therefore always be borne in mind that the first evidence we have of any deviation in direction of the spinal column, is not that of lateral curvature, as judged of by any lateral deviation of the apices of the spinous processes; but the indications are those of horizontal rotation of the bodies of the vertebræ.

According to my observation, horizontal rotation of the bodies of the vertebræ always precedes lateral curvature, as indicated by the fixed lateral deviation of the apices of the spinous processes.

When cases are submitted to our examination in an early stage, we have an opportunity of forming an opinion upon this subject, and I have observed that when lateral curvature of the spine is preceded by, and in its early stage accompanied with, muscular debility, a lateral deviation of the spinous processes always exists, but this is not a fixed or persistent deviation.

When the girl is examined in the erect position this deviation is apparent, but disappears when she lies down; nevertheless it is too frequently pointed to as evidence of the existence of lateral curvature, and the cases are accordingly submitted to a long course of unnecessary treatment; whereas, in truth, this lateral deviation of the apices of the spinous processes, in many cases, only indicates *a weak and not a curved spine*; a condition which may be easily remedied by attention to the general health, light gymnastics combined with the recumbent position for a few hours daily, and the avoidance of any bad position assumed from acquired habits, &c.

When, however, the evidence of horizontal rotation of the bodies of the vertebræ exists, with or without any lateral deviation of the spinous processes—and where the case is not dependent upon, or preceded by muscular debility, the lateral deviation of the spinous processes is frequently absent, or

exists only in a slight degree—the case immediately assumes a more serious aspect. We know that we have the undoubted evidence of the commencement of a series of adapted structural changes affecting the oblique articulating processes and intervertebral cartilages, and that these changes may advance to more serious mischief, and unless checked by judicious treatment, will most probably do so.

The way in which horizontal rotation of the bodies of the vertebræ is produced, by the weight of the body being thrown upon the oblique articulating processes, when a habit is acquired of inclining to one side, and the changes in form which these processes undergo, have been accurately described by Mr. Alexander Shaw. According to this explanation, the oblique articulating processes which are naturally designed to limit and direct the movements of the vertebræ in the different regions of the spinal column—but during growth are too delicate to resist the weight of the body when thrown upon them—gradually become altered in direction and form, yielding to the superincumbent weight which ought to be transmitted directly downwards through the bodies of the vertebræ.

In the diagnosis of lateral curvature of the spine, it is therefore a great fact, and one that should be strongly impressed on the mind, that we cannot rely exclusively upon the relative position of the apices of the spinous processes.

It is true that lateral deviation of the apices of the spinous processes generally occurs, both in slight and severe cases, though not to an extent corresponding to the internal deviation of the bodies of the vertebræ; and in such cases it may be observed only in so slight a degree, that if we rely upon it for diagnosis, we may be led into serious errors of treatment; or it may not exist at all even in some cases of undoubted severity. Moreover, in a numerous and important class of cases which I have described as cases of weak spines, threatening to pass into confirmed curvature, a lateral deviation of the spinous processes indicates only the condition of weak spine,

which in the erect position simulates lateral curvature, rather than any true distortion of the spinal column.

In a diagnostic point of view, too little value has been placed upon an undue prominence of one scapula, or what is generally called a *prominent shoulder*, and when this exists, as it frequently does, without any lateral deviation of the apices of the spinous processes, surgeons are often inclined to give too favourable an opinion of the case, and to regard the symptom as one of little importance.

The fallacy of such an opinion, however, is frequently proved by the progress of the case, when distortion obviously increases; and then some surgeon, who has paid more attention to spinal affections, being consulted, the parents learn with regret that their daughter has a curvature of the spine which has now become incurable, and should have been submitted to systematic treatment at least one or two years previously.

It is much to be regretted that such a state of things should exist in the profession, but so long as the study of lateral curvature of the spine continues to be neglected, as it has hitherto been, this cannot be a matter for surprise.

The fact is, that a fixed prominence of one scapula, or a *prominent shoulder*, is a certain indication of internal curvature of the spine, or rotation of the dorsal vertebræ, by which the ribs, and with them the scapula, are rendered prominent on one side; therefore as a diagnostic indication, the prominence of the scapula is of great importance.

As exceptional conditions which need only be mentioned, we sometimes see one scapula drawn upwards, and its angle rendered prominent by hysterical contraction of some of the muscles, such as the trapezius and levator anguli, and after some months, as a result of this condition, lateral curvature may be produced.

I have seen a few examples of this kind, and in one instance in a girl who was under the care of my late colleague, Mr. Lonsdale, he found it necessary to apply a spinal instrument to prevent lateral curvature. The right scapula was drawn up

nearly four inches, but under chloroform it could easily be replaced. The girl continued at the hospital a long time, but the hysterical affection did not yield to any of the ordinary remedies. The appearances in this case are represented in Fig. 6, *see* p. 43.

I have under my care at the present time, a young lady in whom the right scapula is drawn upwards and rendered prominent in consequence of some malformation which I cannot precisely determine. There seems to be a small process of bone passing between and connecting the superior angle of the scapula, with one or more of the spinous processes of the lower cervical vertebræ. The mobility of the scapula is very limited, but the prominence is considerable in consequence of the scapula being drawn upwards and tilted forwards, and as a result of this, the upper portion of the trapezius is unusually prominent. A dorsal curvature of the spine has taken place, and to prevent the increase of distortion it is necessary to apply a spinal support. These are, however, rare and exceptional cases.

A prominence of one of the breasts, generally the left, is also diagnostic of internal curvature, or rotation of the dorsal vertebræ, and is generally associated with other defects in the symmetrical form of the chest, such as represented in Fig 25, *see* page 109, and lateral deviation of the spinous processes also exists, the case having advanced to external deformity. In some slight cases where we have the evidence of rotation of the bodies of the vertebræ, without lateral deviation of the apices of the spinous processes, there may be a prominence of the left breast, to which attention has been directed, without any spinal curvature being suspected.

A prominence of one hip, generally the right, is also a diagnostic indication of the existence of lateral curvature, or rather of rotation of the bodies of the vertebræ, in the lumbar region.

When the curvature is in the opposite direction, the left hip of course is prominent. When the curvature commences, or predominates in the lumbar region—and we sometimes see cases of single curvature involving the whole of the lumbar

and several of the lower dorsal vertebræ—the hip corresponding to the concavity of the curve becomes unusually prominent, and is sometimes the first and only symptom to which the attention of the patient is directed, and for which advice is sought.

In many cases I have been consulted on account of a prominence and supposed enlargement of one hip, really depending upon spinal curvature which had not been suspected; and it is not unusual to find that such cases have been under treatment for a supposed affection of the hip-joint.

I have now under my care a young lady in whom the right hip-joint is remarkably prominent, and there is a spinal curvature in the lumbar and lower dorsal region, but with very little external deformity; the pelvis is tilted, and consequently produces a shortening of one leg—a condition sometimes, though rarely, met with.

In addition to other treatment, this young lady had been two years under a professed rubber, and the hip had been most sedulously rubbed and pulled during that time. I found the hip-joint to be perfectly healthy and natural in all its anatomical relations, but the tilting of the pelvis and the spinal curvature had not been detected. In a diagnostic point of view, therefore, a prominence of one hip is always of importance.

A diminution of the natural antero-posterior curvature of the spine, either in the dorsal or lumbar region, *i.e.*, a depression, or sinking in, of the dorsal spines between the scapulæ; or an absence of the natural depression in the lumbar region, a condition which renders the spine unnaturally straight in a profile view, is also diagnostic of the existence of internal lateral curvature affecting the bodies of the vertebræ, when rotation occurs without lateral deviation of the apices of the spinous processes.

The diminution of the natural antero-posterior curves generally coexists with slight lateral deviation of the apices of the spinous processes, but it may exist without any such deviation. It is, however, in the dorsal region, always accompanied with some alteration in the relative position of the angles of the ribs, as

respects their transversity, *i.e.*, the angles of the ribs on one side—generally the right—projecting posteriorly, whilst those on the opposite side are depressed; and in the lumbar region with a similar deviation in the relative position of the transverse processes.

We frequently see young ladies in whom there is a prominence of the right shoulder, and a depression of the dorsal spinous processes between the scapulæ, but without any lateral deviation of the apices of the spinous processes, and in such cases we can most positively diagnose the existence of lateral curvature, or rotation of the bodies of the vertebræ in the dorsal region.

This diminution of the natural antero-posterior curvature in the spine, whether associated with any lateral deviation in the spinous processes, or not, may always be regarded as a decidedly unfavourable condition, and if it exists in any marked degree, as represented in Fig. 10, will never be removed by any system of treatment; many cases which otherwise appear to be slight, *i.e.*, without much obvious external deformity, may be at once pronounced to be essentially incurable, as it is one of the indications by which we know that adapted structural changes have taken place in the oblique articulating processes and the intervertebral cartilages, or it may be in the bodies of the vertebræ. In a diagnostic point of view, therefore, our attention must be directed to this deviation in the antero-posterior curvatures of the spine.

The stooping position as diagnostic of lateral curvature in the early stage.

When rotation of the bodies of the vertebræ has taken place, in however slight a degree, the patient cannot stoop in a direct line, and at the same time preserve the symmetrical form of the back. If rotation of the bodies of the vertebræ has occurred, the patient will always stoop in the oblique direction, and the angles of the ribs will be observed to project posteriorly, and give a general prominence, or fullness on the corresponding side; whilst on the opposite side a flattening—in slight cases not amounting to a depression—will be observed.

The spine will also bend or curve forwards, with less

regularity through the region affected, so that it appears less flexible at this part, and remains straighter.

These indications, when present, will form a valuable aid to the diagnosis of internal curvature in an early stage.

Having now described the anatomical deviations which afford undoubted evidence of the structural changes which essentially exist in all cases of fixed, or confirmed lateral curvature, it might be thought that no difficulty could arise in determining whether a young lady has, or has not, a lateral curvature of the spine; yet such a difficulty is, in practice, of constant occurrence, and the public are frequently bewildered by the different opinions given in the same case.

Much of this difficulty evidently depends upon the opinion still generally entertained, that structural changes only appear at a late period, and as the result of the long continuance of the curvature, which in its early stage is but a functional affection depending upon muscular debility, so that when the curvature is not apparently severe, *i.e.*, when there is no conspicuous external deformity, the case is frequently said to be of little importance, and not requiring more than some general attention.

In some cases, when seen at the commencement of the affection, the existence or non-existence of actual curvature must be matter of opinion, the determination of which depends on the practical experience of the surgeon consulted; but the effort I have now made to place this subject on a more definite and scientific basis, will, I hope, prevent much of the uncertainty in forming a diagnosis.

Prognosis of Lateral Curvature. — Extreme uncertainty characterizes the progress of lateral curvature. When a patient is first seen with lateral curvature of the spine, in an early stage, it is impossible to say what course the affection may take if left to itself; or if without any special treatment directed to the spine, the case be treated merely upon general principles, having reference to the health of the patient, such as exercise, change of air, &c.

With or without this general treatment, spontaneous arrest

often takes place in an early stage, a slight and unimportant amount of deformity only remaining through life, as shown in Plate II. Cases of this kind are frequently met with in young adults and at later ages ; or the case may proceed to a severe degree, producing extreme deformity, complete loss of health, and shorten life by favouring the development of some other disease, as consumption, &c.

The knowledge of the fact, acquired by practical experience, that spontaneous arrest does frequently occur, and that it may be promoted by improvement of the general health, has led medical men generally to treat these cases too lightly ; but it is also an undeniable fact, that in many cases, when the patient is again examined after a lapse of one or two years, the curvature will be found to have progressed so much as to be beyond all hope of cure, and the possibility of arrest, or perhaps improvement to a limited extent may be the only prospect. The method by which this is to be attempted will have to be decided, and under any system of treatment will necessarily be found very tedious—generally extending over several years—as well as troublesome and inconvenient.

Surely this is a state of things to be avoided, and I have no hesitation in saying that in every instance it is in our power to prevent such a result by judicious treatment in the early stage. I have no desire to overrate or magnify the importance of these cases, but whilst remembering the fact above stated, that they do not necessarily proceed from bad to worse, I am most anxious to impress upon you the importance of giving a guarded opinion, and of carefully watching the progress and the result of any treatment you may think right to adopt. A considerable number of these cases do turn out badly, but by giving a cautious prognosis and a moderate amount of attention, you will avoid the blame which otherwise you are sure to incur, if the case should take an unfavourable turn.

Impossible as it may be to form a positive opinion as to the future progress of any case of spinal curvature, still there are certain general principles, a knowledge of which will be found

of some use, and speaking from my own experience, I should say that in the opinion which must be given, the prognosis may be considered as *most favourable*.

1st. In those cases commencing between the ages of twelve and sixteen, which in the classification I have adopted have been arranged in the *second* class, as depending upon local and constitutional causes in about equal degrees; more especially will the prognosis be favourable in those in which an hereditary tendency cannot be traced, and the local or mechanical causes predominate, the general health being good. Such cases, under a well-regulated treatment, extending over a period varying from one to two years, undoubtedly yield by far the largest proportion of cures.

2nd. When the curvature occurs in the middle dorsal region, as in this situation we are enabled to control it most effectually by mechanical means, if treatment be commenced at a sufficiently early period; and more especially if the form of curvature is that which I have described as the long single curve.

3rd. When the curvature has assumed the form described as double curve, if the curves are of equal length, so as to counterbalance each other, as shown in Plate II. Such curvatures have naturally a disposition to spontaneous arrest, which may be encouraged by appropriate treatment, but they may also be cured if attended to at a sufficiently early period, whilst little or no external deformity will remain, even if the curvature be not completely removed.

The prognosis must be *unfavourable* in proportion.

1st. As the curvature commences at an early age, more especially I allude to those cases which occur in infancy, or in early childhood, *i.e.*, under twelve years of age—cases which I have arranged in the general classification in the first class, in consequence of the predominance of constitutional causes, such as hereditary tendency, strumous constitution, &c.; and the prognosis must also be unfavourable in consequence of the great length of time during which any treatment adopted, must be continued; this requiring a more prolonged attention than parents can be readily induced to give.

2nd. In proportion to the degree in which the hereditary predisposition is traceable in the family history of the patient, and, although, this generally exists in the cases I have included in the *first* class, it also does so in many instances in those arranged in the second class, in which the curvature commences between the ages of twelve and sixteen years.

3rd. When the curvature exists in the lumbar region, as in this situation we can have but very little control over it by any mechanical means. The transverse processes of the lumbar vertebræ are not adapted to receive pressure, such as can be applied to the ribs, in the dorsal region, by means of a steel plate, so that it is impossible to give the required support.

4th. In proportion to the extent to which the curvature has become developed at the time when advice is sought, and also in proportion as the patient has completed her period of growth. The prognosis must likewise in these cases be influenced by the form of curvature; that which I have described as the long single curve, being most unfavourable if it has advanced sufficiently to cause external deformity, and also when the curvature exists in the lumbar region, and the evidence of rotation of the bodies of the vertebræ exists in a marked degree, a good example of which is represented in Plates III., IV. and V.

5th. When a paralytic condition of the spinal muscles exists, and this usually occurs in those cases of general infantile paralysis, in which both arms, as well as both legs, are affected. In these cases spinal curvature progressively increases, unless checked by appropriate treatment, and the most severe deformity is the result, the long single curve being the form assumed, as represented in Fig. 38, which was taken from a case of this kind.

6th. In cases of a decidedly rachitic character, which I have stated depend more upon inequality in the length of the legs, from unequal distortion, than upon any special liability to deformity in the bones consequent upon rachitic softening. In other cases in which the spinal curvature has been produced, during growth, by local causes, such as inequality in the length

of the legs from malformation, congenital dislocation of one hip, contraction after disease of the hip, or knee-joint, &c. These cases seldom advance to the extreme distortion met with in the other classes above adverted to, but still conspicuous external deformity is frequently produced, unless checked by appropriate treatment. These cases are, however, essentially of an incurable nature.

LECTURE X.

LATERAL CURVATURE OF THE SPINE.—CLASSIFICATION OF CASES.—PRINCIPLES, AND VARIOUS SYSTEMS OF TREATMENT.

Classification of Cases.

IN all books on lateral curvature of the spine you will find the cases arranged according to the different stages, or degrees of curvature, through which the several authors assume this affection to pass. Thus we find the external appearances and symptoms described of the first, second, and third degree of curvature, &c., it being, of course, assumed that a definite order of changes always occurs, and that the cases are essentially of the same nature. Even in books written by orthopædic authorities on lateral curvature, who admit the existence of several forms of this affection, one form only is fully described, viz., that which occurs in growing girls, and supposed to depend upon muscular and ligamentous debility, associated with mechanical causes, such as standing on one leg, &c., the others are simply mentioned.

This may be called the popular form of lateral curvature, but, unfortunately, it appears to be generally assumed as the typical form of this affection, and the treatment recommended has always especial reference to this class of cases, so that we still have presented to us essentially one class of cases, and one method of treatment. This *one idea* leads to serious errors in practice; the treatment itself, whatever it may be, and

however good as applied to a certain class of cases, is brought into disrepute by its failure, in many instances in consequence of its misapplication, and from the pertinacity with which the advocates of each system continue to adhere to one plan of treatment for all cases.

This unsatisfactory state of things can be reformed only by a more extended investigation into the general pathology of lateral curvature, in reference to the constitutional as well as the local conditions under which it arises; and I have endeavoured to prove that the several cases differ essentially in their general pathology—i.e., as to the causes and mode of production; and that the indications for treatment depend upon the pathological anatomy, and must, therefore, vary in the different classes of cases.

A careful observation of lateral curvature of the spine during the last thirty years, in hospital and private practice, has convinced me that the arrangement and classification of these cases ought to be based, not so much upon any differences in the form, situation, and degree of curvature, as upon the relative extent to which the spinal affection can be traced to depend upon constitutional and local causes, with some reference also to the different periods of life at which the curvature may occur.

It is undoubtedly true, that the immediate cause of lateral curvature is, as a general rule, purely mechanical; but the associated constitutional conditions are so variable and so important—acting as the most powerful predisposing causes—and so materially modify the indications for treatment, that these conditions appear to me to afford the best and most scientific basis for a general classification of these cases, which, therefore, I propose to arrange in the three following classes viz.:—

1st Class.—Cases essentially of Constitutional Origin, or in which the Constitutional largely predominate over the Local Causes.

These cases are often hereditary, occurring in two or three generations, and several members of the same family are

frequently affected. They are generally associated with the strumous constitution in a marked degree, and may be arranged in two series or subdivisions, according to the period of life at which they occur: *a*, those cases occurring in infancy or early childhood, *i.e.*, under three or four years of age; and, *b*, those which occur in children, from seven to twelve years of age.

In the first series there is often no history of hereditary predisposition, and though a strumous diathesis may be feared, such is not clearly indicated; the only apparent cause being *general muscular debility*, which may have existed from birth, or have been induced by illness. The children are unable to support themselves in the sitting position, even when a year or a year-and-a-half old, and a lateral curvature of the spine is very readily produced if the nurse should always carry the child on one arm.

In the second series there is usually a history of *hereditary predisposition*, and the children in their general aspect are decidedly strumous. The deformity often increases rapidly, and becomes very severe. These cases are sometimes, but I believe erroneously, considered to depend upon rickets; the spine alone is affected, and there are no indications of rickets in the leg bones, or in other bones of the skeleton; no enlargement of epiphyses; no pelvic deformity, or rachitic conformation of the skull.

There can be no doubt that constitutional causes largely predominate in the production of spinal curvature, when this occurs in children under twelve years of age; and, according to my experience, these cases, from their natural tendency to terminate in severe and conspicuous deformity, are of a very unpromising character.

2nd Class.—Cases depending upon Constitutional and Local Causes in about equal degrees.

Hereditary tendency is not generally traceable in this class, but exists in some instances. The cases included in this class may be arranged in two subdivisions; *a*, *those depending upon*

induced constitutional or general debility, combined with local causes acting mechanically; and b, those clearly of a rachitic character.

a. Lateral curvature of the spine, in the first series of cases, generally occurs between the ages of twelve and sixteen, in quickly-growing girls not of robust appearance, but without any well marked strumous diathesis or hereditary predisposition; though occasionally one, or both of these conditions, will be found to exist. This is the class of cases described by authors on lateral curvature, as depending upon muscular and ligamentous debility; and in this series are generally included that large class of cases which may be more properly described as *weak spines*, and which certainly have no claim to be considered as examples of lateral curvature. There can be no doubt that weak spines frequently pass into, and become cases of confirmed lateral curvature; but according to my observation, more than half the total number of cases of lateral curvature met with in practice are neither preceded, nor accompanied by, any such condition of general muscular debility.

The local causes which most frequently contribute to the production of lateral curvature of the spine in this class, are the *long continuance of certain bad positions*, which may be either acquired as habits, or produced by a defective educational system; or they may be the result of certain occupations. As examples of the former, I would mention *standing on one leg*; this may produce curvature of the spine even in girls possessing the full natural amount of muscular strength, though it will do so more readily in those who exhibit some muscular debility.

The long continuance of the sitting and stooping positions during education. I have frequently seen spinal curvature in young ladies who do not exhibit any want of muscular strength, but have been in the habit of sitting as much as eight hours a-day to masters at school, and also in girls who devote most of the day to drawing and writing.

The habit of sitting cross-legged which some young ladies adopt for several hours a day whilst reading, with a book

placed on the knee, one elbow resting on the thigh, and the head inclined forwards and resting upon the hand; such a position must necessarily tilt the pelvis and curve the spine in the lumbar and lower dorsal regions, and if long continued in a growing girl, will infallibly produce curvature of the spine. A remarkable instance of curvature produced by this cause recently came under my observation, in a young lady aged seventeen years, who measured five feet eight inches in height, and who had grown four inches a year for three years, according to the statement of her father, who had registered her growth during this period; yet she presented every appearance of good health, and possessed a full average amount of muscular strength. The habit of sitting cross legged was evidently the immediate and essential cause of the spinal curvature, aggravated by *excessive horse exercise*, which in delicate girls sometimes leads to spinal curvature in the lumbar region. Another series of causes may be traced to

Certain occupations which render necessary the long continuance of the same position.—From this cause we frequently see spinal curvature both in boys and girls, and though in many instances associated with muscular debility, I have also frequently seen spinal curvature thus produced coexisting with the full amount of muscular strength. The occupations which most frequently produce spinal curvature in females are *needlework, envelope and book-folding, flower-making, ironing, nursing children, carrying heavy weights, &c.*

Although the local causes above enumerated may be in some instances of themselves sufficient to produce lateral curvature, still they more frequently contribute to this result when coexisting with constitutional or induced general debility, perhaps consequent upon an attack of fever or some other illness. Essentially, therefore, in the class of cases we are now considering, and which generally occur in growing girls between the ages of twelve and sixteen years, constitutional and local causes combine in about equal proportions to produce the spinal curvature.

b. The second series essentially includes cases of lateral curvature

*clearly of a rachitic character, i.e., associated with the general rachitic conformation of the skeleton, and the curvatures of the long bones of both the upper and lower extremities invariably occurring in this affection; more especially I allude to the dwarfishness of stature and general arrest of development of the bones, most conspicuous in the legs and pelvis; the curvatures of the leg-bones, and to a less extent of the bones of the upper extremities, with the enlarged epiphyses; the deformity of the pelvis; and the general conformation of the skull, &c.**

This rachitic condition is very seldom hereditary, and I believe is generally dependent upon imperfect lactation. The worst cases which have come under my observation have occurred, either in the children of healthy parents, or of somewhat delicate, but not rachitic parents; and generally only one child is thus affected in a family, the other children being perfectly healthy; occasionally I have seen two or three cases in a family, and in a few instances, all the children in the same family are more or less affected. In every instance, however, imperfect lactation has been clearly traceable, the mother's milk being either insufficient in quantity or poor in quality; and the children have generally been half suckled and half fed, the food being of a farinaceous kind, such as *tops and bottoms*, various kinds of biscuits, &c., all of which are unsuited to the requirements of a child during its period of early growth and rapid osseous development. I believe rickets therefore to be an induced, and not an hereditary constitutional condition.

Lateral curvature of the spine in these cases very rarely occurs at an early period, so far as my experience has gone. I have never seen rickety curvature of the spine in very young children, and in several cases of rickets in its worst forms, in children from four to twelve years of age, now under my care, the spines are still free from lateral deviation, though the older

* For an account of the peculiarities of the rickety skeleton and their explanation, see a very able paper by Mr. Alexander Shaw in the *Transactions of the Medico-Chirurgical Society*, Vol. XVII, 1832, London.

cases exhibit rather severe lordosis; yet in nearly all the rickety adult specimens in museums, severe lateral curvature forms a conspicuous part of the general deformity.

I conclude, therefore, that in cases of rickets, the lateral deviation of the spine usually takes place towards the completion of growth, and continues gradually to increase long after that period, perhaps, even through life. The development of the lateral curvature appears essentially to depend upon the equilibrium of the spine having been for a long time disturbed, either by deformity of the legs, the curvature in which frequently renders them of unequal lengths, or by distortion of the pelvis.

I do not deny that lateral curvature of the spine may sometimes be seen in cases of general rachitis at an earlier period than twelve years of age; but such cases I believe to be exceptional, and their explanation may always be found in one leg being more deformed and shorter than the other, so that confirmed tilting of the pelvis has been produced.

As a general rule, the opinion that lateral curvature of the spine occurs at a late period, in cases of rickets, will, I believe, be found to be correct. This statement, I am aware, is directly at variance with that of some authorities who consider that the curvature in these cases generally commences under five or six years of age. The probable explanation of this discrepancy is, that a very different class of cases from those which I have described as belonging to the rachitic series, are included by the authors alluded to, in the rachitic class of distortions, viz., such cases as I have arranged in the first class, generally depending upon hereditary tendency to curvature, associated with a strumous constitutional condition.

I regard the lateral curvature of the spine, therefore, in the rachitic cases as depending upon induced constitutional and local causes in about equal degrees; but the local are probably of more importance than the constitutional.

In children affected by rickets, the vertebræ are said to be softer than in healthy children; and the general statement is, that in these cases the bones become much more altered in

shape than in the other forms of curvature; but this does not appear to be confirmed by an examination of the rickety skeletons in museums. In St. Thomas', the College of Surgeons, and other museums, are numerous specimens of severe lateral curvature, consisting of the spinal column, with the pelvis attached; and in those specimens in which the pelvis has attained its normal size, and is free from deformity (mostly examples of the cases described in Class I), and which we are justified on this account in excluding from the class of rickety distortions,* the vertebræ are seen to be, in many instances, more altered in shape than in the specimens of true rachitic curvature, associated with pelvic and other distortions.

It must be especially borne in mind that it is only in the class of true rachitic curvatures that any distortion of the pelvis takes place, and, therefore, it is only in these cases that any risk to life exists from pregnancy.

3rd. Class.—Cases essentially depending upon Local Causes acting Mechanically so as to disturb the Equilibrium of the Spinal Column.

Lateral curvature in these cases may occur at any period of life, though most apt to form in a severe degree previous to the completion of growth. The cases which I propose to include in this class are essentially unconnected with any constitutional affection, or hereditary predisposition, and frequently coexist with the full natural amount of muscular strength. My late colleague, Mr. Lonsdale, observed "the common lateral curvature occurs most frequently in young women, who, though comparatively of a delicate constitution, do not, as a rule, offer any mark of disease; while there are a very large number who are really fine healthy young women."†

Further inquiry, however, into the history of these cases, will

* See observations on this point, by Mr. John Shaw; and also by Mr. Alexander Shaw, above referred to.

† "Analysis of 3000 Cases of Deformities, with Remarks," by E. F. Lonsdale, published in the *Lancet*, September 1st and September 8th, 1855.

generally reveal the existence of some local cause, which of itself has been sufficient to produce the curvature.

From ironing and also from nursing children I have seen spinal curvature produced in girls of an unusually muscular and robust appearance, and in such instances many would contend that the excessive use of the right arm was the essential cause; but I believe the position alone, with its necessary result of irregular distribution of weight, to be a much more powerful and direct cause of the spinal curvature.

As examples of spinal curvature produced by certain occupations in boys exhibiting great muscular strength, I would refer to the case of a boy who had long been in the habit of carrying heavy goods up a spiral staircase with a low ceiling at a pawnbroker's shop. This was a stout, muscular and vigorous lad, but a severe lateral curvature, as shown in the cast exhibited, was produced by his occupation. Also a healthy, muscular boy under my care, who had been two or three years at a gold-lace factory, and was accustomed to wind the lace, which obliged him to stoop sideways. In addition to the habits and occupations above referred to, I would also mention

Inequality in the Length of the Legs from any cause.—By many writers on spinal curvature, especially those of the mechanical school, who undertake to prove mathematically that certain results must necessarily follow from any given mechanical deviations, inequality in the length of the legs has been greatly exaggerated as a cause of spinal curvature; but in contradiction of these mathematical sequences, cases may often be seen in which inequality in the length of the legs has existed for many years, without producing spinal curvature. The fact is, it does not necessarily do so when associated with the full amount of muscular strength. Many patients who have recovered from hip-joint disease with contraction of the limb, or who walk lame from contracted knee-joint after disease, appear to have curvature of the spine when walking or standing; but when examined lying down, or

whilst standing with a book under the short leg, sufficient to bring the hip-joints to a level, it will be seen that little or no permanent spinal curvature has been produced. The muscular power and active motion appear to prevent spinal curvature in many of these cases.

In cases of *inequality in the length of the legs from muscular paralysis and imperfect development of one limb*, lateral curvature of the spine in the lumbar region is always produced, but even in these cases it is not often of a severe form.

Inequality in the length of the legs from congenital dislocation of one hip-joint is also sure to produce lateral curvature, but many years are required to bring about this result, and even then it is much less than the mathematical authorities would lead you to expect it must necessarily be.

The same may be said of the cases of *congenital shortening of one leg*. About seven or eight years ago a child was brought to me with congenital shortening of one leg, depending upon deficiency in the length of the tibia and fibula, to the extent of about an inch and a half; the foot was in the position of valgus, and the outer malleolus indistinct; I suspected the tibia and fibula were fused at their lower extremities, and that the outer malleolus was either deficient or very imperfectly formed. The leg below knee in this girl is now four inches shorter than the opposite leg, but she is strong and muscular, and very little curvature of the spine has been produced; she wears a high boot with steel supports to the calf of the leg, and straps to keep the foot in a straight position. Dr. Little completely rejects inequality in the length of the lower extremities, as one of the causes certain to produce spinal curvature, and observes:—"I have examined no case in which, notwithstanding the shortening, other causes of lateral curvature did not exist. On the contrary, it is very remarkable, according to my experience, that difference in the length of the lower extremities is so rarely accompanied with deformity of the spine."*

The effect of a wooden leg in producing spinal curvature has also, I believe, been greatly exaggerated. Although by some

* Little "On Deformities," page 363.

authorities it has been attempted to prove mathematically that spinal curvature must result from this cause, I have examined several young men who have worn a wooden leg for five or six years without any spinal curvature being produced; nevertheless, a slight spinal curvature is sometimes seen in these cases.

Amongst the causes which act mechanically, so as to disturb the equilibrium of the spinal column, though not themselves of mechanical origin, I would enumerate *diseases of the chest*, such as empyema, which, after the evacuation of the pus, and the permanent shrinking and collapsing of the lung, produces a most severe form of lateral curvature; not, I believe, by the tonic contraction and structural shortening of the muscles on the affected side, as has been explained by Dr. Little,* but in consequence of the position assumed by the patient, in part from the pain suffered, and in part to favour the increased respiratory action carried on by the healthy lung on the opposite side. Although a marked loss of balance of muscular power exists in these cases, I believe position, which is only in part dependent upon this disturbed muscular balance, to be the more powerful and more immediate cause of the spinal curvature.

Other diseases of the thoracic and abdominal organs, such as tumours, &c., might be enumerated in the same category, which would also include the cases of lateral deviation, not often severe, which result as consecutive curvatures, in cases of caries of the spine, after angular projection has taken place, and may occur either above or below the angular curvature.

I have now enumerated the local causes which most frequently produce lateral curvature of the spine, essentially unconnected with any constitutional disorder, or hereditary predisposition to this affection. The importance to be attached to the disturbed balance of muscular power—undoubtedly existing in many of these cases—as an active cause in the production of the deformity, will be differently valued by those who study

* *Op. cit.*, page 362.

these affections, according to the leaning they may have towards the different theories of the production of lateral curvature in its more ordinary forms; but according to the physiological views, which I have explained in the second lecture, I am induced to attach a higher degree of importance to the mechanical effect of the long continuance of certain positions, in the production of which the muscles are often entirely passive.

When in many positions assumed by healthy, muscular people, certain muscles are called powerfully into action, the muscular force seems to be exerted rather to prevent or limit the curvature, than to produce or increase it—the muscles in the concavity of the curve remaining soft and inactive, whilst those on the convexity are tense and prominent.

The classification of cases of lateral curvature of the spine, which I have now described as based upon the relative degrees in which the constitutional and local causes contribute to the production of curvature, may not be considered as including a very rare form of lateral curvature, viz.: that depending upon *congenital malformation of the spine*. I have not had the opportunity of dissecting or examining any specimen belonging to this class; but malformation, depending either upon excess, or deficiency, of the bodies of the vertebræ, the lateral halves

of which are unequally developed, has been met with. A very remarkable example of this kind exists in the Pathological Museum at Vienna, and has been described by Rokitansky.*



Case of congenital curvature of the spine, with tilting of the pelvis in a child, aged two years.

A case probably belonging to this class, was admitted into the Royal Orthopædic Hospital under my care. The patient was a child aged two years, and severe lateral curvature of the spine, involving the whole of the dorsal and lumbar vertebræ, existed, the convexity of the curve being towards the left

* "A Manual of Pathological Anatomy," Sydenham Society's Edition, Vol. III., page 228. 1850.

side, as shown in Fig. 43. The pelvis was also tilted to a remarkable extent, and seemed to depend upon some obscure malformation of the lumbar vertebræ, probably involving the sacrum. The distortion was said by the parents to have been congenital. I endeavoured to apply a mechanical support, with the view of preventing increase of distortion, but the difficulties were so great as to give little hope even of this being effected.

There is also in the museum of the hospital a cast from a very similar case.

In such cases of congenital malformation the curvature will certainly increase when the child is able to assume the sitting position, and distortion will proceed when it begins to stand and walk, the mechanical condition of irregular distribution of the weight of the head and upper extremities then coming actively into play.

Principles; and Various Systems of Treatment.

The treatment of lateral curvature of the spine, if conducted in accordance with the views of the general pathology of this affection, which I have endeavoured to establish in these lectures, must be both constitutional and local in nearly all the cases which occur during childhood and youth. In some few instances, in young people, the spinal curvature will be found to depend almost entirely upon local causes acting mechanically, as described in Class 3, and in such cases the treatment will be essentially local. In the cases of lateral curvature also requiring treatment at the more advanced periods of life, say from thirty to fifty years of age, or even later, the treatment will be purely local, the object being not to cure, but to check and arrest the increase of the spinal curvature.

With few exceptions these are cases in which the spinal curvature neglected or badly treated during the period of growth, when alone a cure can be anticipated, has increased under circumstances of failing health, or in consequence of its own mechanical conditions, such as the disproportionate length

of the dorsal to the lumbar curve, or *vice versâ*. But in all other cases the constitutional conditions, upon which I have laid so much stress, as a causative influence in the production of lateral curvature, demand a large share of attention, and the treatment of the spinal affection will be successful in proportion as the constitutional and local means are judiciously combined.

The constitutional conditions under which lateral curvature of the spine is found to occur, have been already described, but may again be enumerated, as,

1st. *General debility*, which sometimes exists from birth, and favours the production of spinal curvature even in infants from six months to two or three years of age: and in other cases when the debility is induced by febrile and other affections, it exerts a similar influence during the period of youth and active growth, often leading to the production of spinal curvature in girls from twelve to sixteen years of age.

2nd. *An hereditary predisposition* to spinal curvature, frequently coexisting with a *consumptive tendency*, a combination of causative influences, which we meet with in cases of lateral curvature, occurring in girls from seven to twelve years of age and sometimes later; in such cases the curvature has a marked tendency to increase rapidly, and terminate in conspicuous deformity.

I believe it to be the opinion of those physicians whose experience is the largest in consumptive cases, that lateral curvature of the spine rarely coexists with tubercular disease; an opinion which would seem to prove that the tubercular diathesis does not favour the production of spinal curvature in any marked degree. The frequency of consumption in the male, as well as the female sex, and the infrequency with which lateral curvature occurs in the male sex, would also favour this opinion; unless we regard the physical influences under which the two sexes are placed as sufficient to explain this difference, a conclusion which I think can hardly be granted to the full extent required by the argument.

An hereditary predisposition to lateral curvature, is, without

doubt, the condition which can generally be traced, and to which I believe the first importance must be attached ; but, coexisting with this condition, we have also frequently a family history of consumption—one of the parents, or, as in many cases which have come under my observation, several members of the family having died of consumption—and in several cases of spinal curvature belonging to this class, I have known the patient also die of consumption.

We may, however, often be misled as to the consumptive tendency, if we rely upon the general aspect and appearance of the patient, when this may seem to favour such an opinion, and may even be combined with a family history of consumption. In many such cases which have been under my care, generally in young ladies, when the increase of the spinal curvature has been arrested by mechanical support, combined with constitutional treatment, the patients have been restored to a good state of health, and remained so after the lapse of many years, so that the symptoms which excited so much alarm must be regarded as having depended largely upon the spinal curvature.

When the constitutional conditions which I have described exists either singly or in combination, they must greatly influence our views as to the course to be adopted, and be regarded as sufficient to negative some methods of treatment, such as complete recumbency, by which I mean, *lying down for one or two years*, which would only more completely exhaust the constitutional powers of the patient ; and also *gymnastics*, when employed as a system of strong muscular exercises, which only fatigue the patient without improving the spinal curvature.

Lying down for a period of from four to six hours a-day, together with light gymnastic exercises, is the treatment best adapted to such cases, at the commencement of the spinal affection, when curvature is threatened, rather than positively formed ; but if curvature has actually taken place, then mechanical support must be combined with partial recumbency and light gymnastic exercises.

THE CONSTITUTIONAL TREATMENT in these cases must be regarded as at least of equal importance with the local treatment, and every effort made to improve the general powers of the patient. For this purpose I have found the free exhibition of the hypophosphite of lime and preparations of iron the most useful. Generally I direct five grains of the lime to be dissolved in a wine-glassful of water, to which ten drops of the tinct: ferri: perchlor: may be added, and taken twice a-day, at or directly after meal times. In addition I give half-an-ounce of cod-liver oil to be taken twice a-day, an hour after meal times, and recommend the use of wine or beer as the patient may prefer.

The influence of soil and place of residence is also of the greatest importance, and, I advise the removal from large towns, damp situations, and clay soils, to high and dry situations, on a chalk soil. The great improvement in the general health and strength of delicate children, and growing girls with spinal curvature, which I have seen follow a change of residence from such counties as Lincolnshire, Cornwall, Devonshire, &c., to high and dry situations on chalk-hills or downs, has led me to recommend such a change of residence in these cases where practicable. To these measures we may also add the use of the cold bath, where it can be borne, followed by friction to the back, and free out-door exercise.

THE LOCAL TREATMENT of lateral curvature of the spine is that to which the attention of the profession has been generally—I might almost say exclusively—directed; and at different periods, various methods, or so-called *systems of treatment*, have sprung into existence, through the advocacy of those who have specially devoted their attention to the treatment of this class of affections; and each *system* in its turn has more or less completely enjoyed the support of public opinion, and the sanction of the profession.

I have already enumerated, in the first lecture, the most important of these systems, or those which have received the greatest weight of authority; and will now again advert

to them in reference to the anatomical and pathological principles upon which they are based, and examine how far these are compatible with the views I have brought forward in these lectures, in reference to the anatomical construction, and mechanism of motion of the spinal column, and the pathological conditions which, I believe, will be found to exist in every case of lateral curvature, however slight. We have, then:—

1st. The system of *complete recumbency*.

2nd. The system of *muscular exercises or gymnastics*.

3rd. The system of *cutting the spinal muscles*.

4th. The system of *mechanical extension*.

5th. The system of *mechanical treatment by support and pressure*, applied by means of spinal instruments.

All these different systems are reported to have been in every way successful and satisfactory in effecting the cure of lateral curvature of the spine; and the perusal of the various works or treatises, in which these systems have been advocated, serves only to impress one with the conviction that lateral curvature of the spine has even at the present time no fixed pathology; and therefore no fixed principles of treatment have as yet been determined.

1st. THE SYSTEM OF COMPLETE RECUMBENCY, by which patients used to be condemned to constant lying down for at least one or two years, and frequently for a much longer period, has had many advocates in this country; but its injurious effects upon the general health, as well as its complete failure to cure the spinal curvature, except in its slightest forms, has led to its discontinuance as a system. Its disadvantages have been so loudly declaimed by the advocates of other systems, and more especially by those who profess to cure lateral curvature by gymnastics, as well as by those who assert the curability of spinal curvature by means of spinal instruments, that the advantages which undoubtedly belong to recumbency, have been of late years to a great extent lost to the public; and

the treatment of spinal curvature has been proportionably less successful than it would have been, if the views taken of its pathology and treatment had been based upon more accurate observation.

The great object of recumbency is to relieve the spine from the superincumbent weight of the head and upper extremities, which it is obviously unable to support when curved, or even disposed to curvature; and as the immediate cause of curvature of the spine is undoubtedly mechanical in its nature and action, viz., the irregular distribution of the weight of the head and upper extremities, the immediate object is most completely effected by the patient assuming the recumbent position.

All the mechanical conditions upon which lateral curvature so much depends, are thus removed, and the patient during recumbency, relies upon her constitutional strength and powers of development and growth. These are, in many instances, sufficient during the period of youth to lead to the complete reparation of such structural damage as the intervertebral cartilages and oblique articulating processes may have sustained, when the curvature is slight and of recent formation.

I regard lying down, therefore, during the period of active growth, as essentially *a curative means* in cases of spinal curvature; and whilst I reject it as *a system* to be relied upon exclusively in any class of cases, I recommend its adoption in every case during the period of growth, in conjunction with such other means as may be thought advisable; in some instances with gymnastic exercises, and in others mechanical support; occasionally, also, in conjunction with both these methods of treatment.

I would here observe, that there is no greater error than to suppose that these different methods, or so-called systems of treatment, are essentially incompatible with each other; their objects, it is true, are very different, yet both theory and practice teach us that in many instances they may

be most advantageously combined for the benefit of the patient.

As a general rule, I advise recumbency in proportion as the spinal curvature predominates in the lumbar region, in which situation it must be admitted that mechanical support can be of little use; here there are no ribs against which pressure can be exerted, and no one will contend that the transverse processes of the lumbar vertebræ are adapted to receive mechanical pressure, which through them can be beneficially exerted upon the lumbar vertebræ.

With regard to the extent to which I recommend lying down, I would observe that in ordinary cases I advise recumbency at least during four or six hours daily; and this can be borne with comfort and without any disadvantage to the general health, if the patient use the reclining chair represented in Fig. 50.

2nd. THE SYSTEM OF MUSCULAR EXERCISES OR GYMNASTICS, as a curative means in the treatment of lateral curvature of the spine, has been relied upon with more confidence by Continental than English surgeons; and according to the statements made by the leading professors of this system, lateral curvature is certainly cured when the deviation is slight, and as certainly arrested when more severe; hence it is assumed to be at least equal, if not superior, to other methods of treatment.

The pathological idea upon which this system is based, is that lateral curvature essentially depends upon muscular debility, and the argument therefore is, if muscular debility be the cause, will it not be desirable to strengthen the muscles by means of a proper system of gymnastic exercises; rather than apply mechanical support, which must, by superseding the necessity for muscular effort, tend to weaken the muscles to a corresponding extent; or than to adopt a system of lying down, which would still further debilitate both the system and the spinal muscles.

The argument is logical and attractive enough, both to the public and the profession, who generally adopt the

muscular debility theory of the production of lateral curvature; but this theory can only apply to a limited number of cases. I have already stated that certainly less than half of all the cases of lateral curvature which have passed under my observation, have been neither preceded nor accompanied by any muscular debility; and that even when muscular debility has been present, other causes, both constitutional and local, have coexisted, and appear to me to be of not less importance than the condition of muscular debility.

Let it be admitted, however, that in many cases an increase of muscular strength is desirable, and the question which naturally follows is, can this be so obtained, as directly to cure, or to contribute to the cure of lateral curvature of the spine?

If in any case of lateral curvature all the muscles of the spine could be at once raised to their maximum of power, the effect only would be to arrest the curvature at that point; cases of moderate severity frequently undergo spontaneous arrest where the general health and muscular power are improved, though I believe this only occurs when the mechanical conditions of the curvature—more especially the equality in length of the dorsal and lumbar curves—are favourable to such a result; but in such cases no advance is made towards straightening the crooked spine, which must be considered the main object of treatment.

A general increase of muscular strength being thus considered useless as a curative means, it may be asked, cannot we by special muscular exercises develop only the muscles which would tend to correct the spinal curvature? By the gymnastic professors it will doubtless be contended that we can; but I have no confidence in the curative effects of any system of special muscular exercises, whereby the muscles on one side of the spine are sought to be particularly developed.

I believe such a result to be practically impossible, for two reasons, 1st: The anatomical difficulty, arising from the number and complex arrangement of the spinal muscles, of stating precisely in any given case the exact muscles and portions of

muscles, the increased power of which would act beneficially on the curvature; and 2nd: The impossibility of strengthening these particular muscles and portions of muscles, if they could be selected, without at the same time strengthening other muscles, the increased action of which would at least neutralize their effect.

Another, and I believe a fatal objection to the pretensions of the muscular exercise, or gymnastic system, is, that it rests upon the idea of free motion or surface-play being allowed at the articulations of the vertebræ, and an absence of structural changes in the articular surfaces; in fact, upon the idea of the anatomical analogy between the articulations of the vertebræ and the movable articulations of the extremities, and consequently upon the idea of an analogy in the pathological conditions attending the distortion of the spine, and those of the limbs.

I have, however, endeavoured to prove that there is a complete absence of any analogy between the vertebral articulations and the movable articulations of the extremities; and that no curvature, however slight, can exist without structural changes affecting the intervertebral cartilages and the oblique articulating processes, in a degree proportionate to the curvature. Now, it cannot, I imagine, be maintained by any one who has studied the nature of these structural changes, that they can be removed by any system of gymnastic or muscular exercises.

The muscular exercise, or gymnastic system, must therefore be rejected as a system capable of curing lateral curvature of the spine; but, nevertheless, when used judiciously, and in conjunction with other means, in cases of slight lateral curvature associated with muscular debility, there can be no doubt of the great value of a well-regulated system of gymnastic exercises.

In cases of *weak spine*, which threaten to pass into actual curvature, cases of *threatened curvature*, occurring in girls from twelve to sixteen years of age, gymnastic exercises are invaluable; and in conjunction with the use of the reclining chair for about four hours a-day, may be con-

fidently relied upon as the best *preventive* means at our command, the general health at the same time being improved by such constitutional means as may appear to be indicated. In cases of slight curvature I also employ gymnastics, in combination with partial recumbency, and mechanical support by the lightest form of spinal instrument, such as the Eagland belt; and now from long experience I am enabled to state that this combination of means contributes to a favourable termination, much more certainly, than the employment of either system alone.

The gymnastic exercises which appear to me to be the best adapted for strengthening the spinal muscles equally on both sides, are those used by means of the *hand-swing*, the *elastic chest expander*, and the *act of drawing up a weight from the ground*, which may be imitated by a short and strong cord of vulcanized india-rubber attached to the ground, as represented in Fig. 52. This is the movement of the *top-sawyer* at the saw-pit. More varied exercises may also be employed, but essentially these appear to me to be the most useful for children. For girls and boys a little older, the more powerful exercises, shown in Figs. 55 to 59, may be recommended.

3rd. THE SYSTEM OF CUTTING THE SPINAL MUSCLES. In direct opposition to the idea of muscular debility and the treatment by gymnastic exercises, we have the theory of M. Guérin that lateral curvature of the spine is produced by the active or tonic contraction of some of the spinal muscles, in the same way that club-foot, wry-neck, and various contractions of the limbs are known to be frequently caused; and upon this pathological idea M. Guérin has recommended, and for many years extensively adopted, the practice of dividing the spinal muscles. The operation, however, has found but few advocates in France, and still fewer in England.

I have already discussed at some length, and I hope have succeeded in showing the fallacies upon which this theory is based. It is unnecessary, therefore, for me to say more in reference to the practice arising out of it, viz., the section of the

spinal muscles, than that I entirely disapprove of the operation, and regard it essentially as an unsound and unscientific procedure; and that I do not believe there are any cases of lateral curvature in which such an operation can ever be called for.

Amongst those who have strongly opposed this operation may be mentioned Mr. Bishop, who in his well-known work on Deformities* makes the following observations. "In Memoirs read before the Académie Royal de Médecine de Paris, M. Guérin stated . . . that he had obtained the most satisfactory results from dividing the sacro-lumbalis and longissimus dorsi muscles in curvatures of the spine. In order to ascertain the truth of these statements, Malgaigne investigated the condition of the patients placed under M. Guérin's treatment; and in a memorial addressed to the Academy† reported that, of the twenty-four cases described as convalescent, he could not find one that was permanently cured; that others, instead of being improved by the operation, were decidedly injured; and he detailed the cases in which this had occurred. This provoked a discussion in the Academy of a violent and acrimonious character, and a commission was appointed to investigate the matter. The surgeons who were charged with this inquiry, reported that the statements of Malgaigne were very exact, that M. Guérin had not succeeded in completely curing curvatures of the spine, and that spinal myotomy would prove a useless, if not a dangerous, method of treatment. They stated, moreover, that they had never witnessed any good effects from dorsal myotomy.

"Malgaigne and Bouvier‡ contend that not only is the division of the sacro-lumbalis and longissimus dorsi muscles not attended with any advantages, but the latter, on the contrary, maintained, very rationally, that the muscles in question are

* *Op. cit.*, London, 1852, page 57.

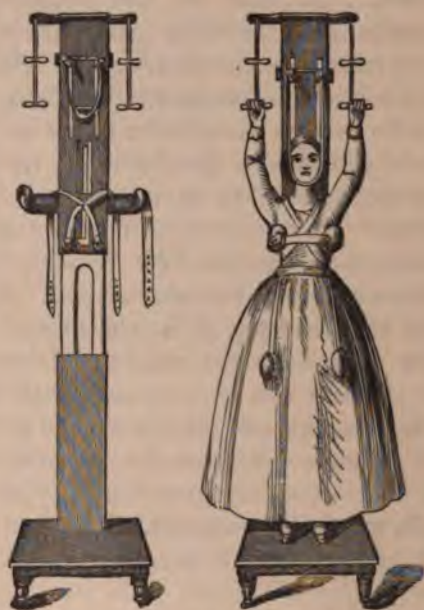
† "Mémoire sur la valeur réelle de l'Orthopédie, et spécialement de la Myotomie rachitienne dans le traitement des déviations latérales de l'épine," par M. Malgaigne. *Comptes Rendus*, Tome XII, Avril 15, 1844.

‡ "Archiv. Gén. de Méd.," Août 4, 1843.

constantly required for the movements of the trunk, and that there is no advantage to be gained by their section which cannot be obtained by other means."

4th. THE SYSTEM OF MECHANICAL EXTENSION. The idea of straightening a crooked spine by the process of stretching it, is of ancient date; the system of mechanical extension, employed both in the erect and the recumbent positions has been very

FIG. 44.



Apparatus for stretching the spine in the erect position, called the "Spine Elongator," invented by Mr. Stafford

generally adopted throughout the Continent, and is still in vogue to some extent. In England also the practice was in favour forty years ago, but never so generally adopted as in France and Germany.

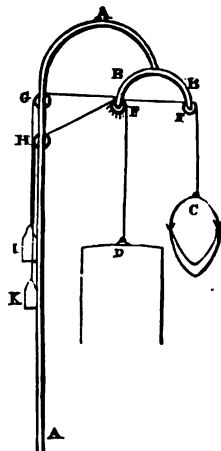
Mr. Stafford advocated the plan of *extension in the erect position* in severe cases, and from his work the drawings of the apparatus employed (see Fig. 44) are copied.

In reference to this apparatus, Mr. Stafford observes, "Lateral exercise, however, will not always recover a lateral curvature. The spine is sometimes so completely distorted, and the vertebral column so entirely thrown out of the centre of gravity, that the muscles have lost their power. They are so stretched on the convex, and so contracted on the concave side of the curve, that they cannot act. In such cases lateral exercise will not alone be sufficient. More must be done. The spine itself must be elongated; and the best method of accomplishing this is by the gravitation of the body. To effect this object, I have invented a machine by which the patient can be raised up from the ground by the upper part of the body, while the lower part hangs suspended. Hence the lower part, by its own gravitation, and by additional weights being hung round the hips, gradually elongates the spinal column until it becomes nearly, if not quite, for the time being, straight. In this manner the muscles and ligaments of the vertebræ are stretched. The muscles on the concave side are lengthened; whilst those on the convex are shortened, and allowed to contract, whereby they are both put into a more favourable position to pull back and retain the vertebræ in their situation."*

Mr. John Shaw approved of the plan of extension, only to a limited degree, and in conjunction with muscular exercises, shampooing, and partial recumbency; and then adopted the plan of extension in the horizontal position, using the exercising-plane represented in Fig. 54, with some additions, *see* p. 340 of his work previously

* "Two Essays on Diseases of the Spine," R. A. Stafford, London, 1844, page 76.

FIG. 45.



Apparatus for making extension from the head and shoulders, whilst the patient is in the sitting position, by means of weights and pulleys. AA is a steel rod, the upper part being in form of an arch; it is to be fixed into a brass socket, on an upright piece of wood attached to the back of a chair. To the arch, the semicircle BB is riveted; and at the extremities of BB the pulleys EF are fixed. In the rod AA the pulleys GH are placed; and to the head-piece C and shoulder-piece D, cords with weights are fastened. Copied from J. Shaw's work, p. 245.

referred to. "But," he observes, "as the discipline is rather severe, we should contrive means to enable the patient to sit up occasionally. This is easily done and without any risk of losing what has been gained by the exercises and rest I have lately used the apparatus sketched below; it appears complicated, but is in fact, very simple."

The idea with which Mr. Shaw used this apparatus was not so much that of making active extension, as of maintaining the advantage gained by extension in the horizontal position, whilst the patient by the aid of the crane, with weights and pulleys attached, was enabled to assume the sitting position, and as he states, "could write, draw, or practise at the pianoforte."

A contrivance somewhat resembling the above has, however, been used with a very opposite view—active extension being relied upon as a means of cure; and some time since I saw, in a private establishment for the treatment of deformities near Portman Square, a sort of hanging contrivance, by which patients were drawn up by the head off the ground, and allowed to remain suspended in the air for a certain time.

The method of *extension in the horizontal position* is now seldom, if ever used in England; but in the private institution just referred to I saw several extension couches divided transversely in the centre, so that the two halves could be separated by machinery when the patient was fixed on to it by straps, &c.; the head and upper extremities being fixed to one half, and the legs to the other. I was informed, however, that neither the crane above referred to, nor the extension couches, were then used in the treatment adopted in that establishment, the system employed being essentially gymnastic.

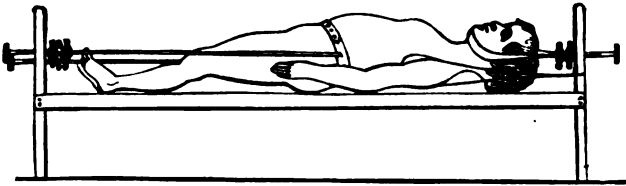
The principle upon which the extension couches act to stretch the spine, with the patient in the horizontal position, is one which has been in former times adopted by a great variety of contrivances, representations of which are to be found in various works. Mr. John Shaw, when alluding to the different machines which have been invented for the

purpose of stretching the spine, gives a representation of that drawn in Fig. 46, and observes, "The wood-cut above represents the latest invention of this kind. It is used in Paris in an Institution called the Orthopédique," dated 1825.

Mr. Shaw objects to this and other contrivances which keep the spine stretched, without at the same time exercising the muscles; and speaking of the above apparatus, remarks, "I have already had an opportunity of knowing that the plan has failed, even under the superintendence of the inventors; and it will not now be denied that the confinement must be injurious."

I have thus alluded to some of the various methods of extension, as matters rather of historical interest than practical importance at the present time.

FIG. 46.



Apparatus for stretching the spine in the horizontal position, used in Paris, at the Orthopédique in the year 1825. Copied from John Shaw, p. 67.

A more intimate knowledge of the series of adapted structural changes which, as I have shown in the preceding lectures take place in all cases of confirmed lateral curvature, leads to the conviction that no practical good can result from the system of mechanical extension, either in the erect or recumbent position.

5th. THE SYSTEM OF MECHANICAL TREATMENT by means of spinal instruments. The idea of straightening a curved spine by means of mechanical contrivances, described as portable instruments, fixed on the body, and constantly worn by the patient without the necessity of lying down, is of modern date, and was strongly advocated by the late Mr. Tamplin, and became for a time the English orthopædic

treatment. These instruments were believed by Mr. Tamplin to act upon the same principle as we adopt in straightening a bent knee, hip, or elbow-joint, and this plan has been advocated by the majority of English orthopædic authorities of late years to the exclusion, it may be feared injuriously, of all other methods of treatment.

The English public, as well as the profession, had seen the very unsatisfactory condition of the treatment of lateral curvature of the spine by the *system of recumbency*; and the general advance in the construction of orthopædic instruments for the cure of club-foot, &c., led gradually to the improvement of such portable contrivances for supporting the spine, as had been previously employed by Tavernier and others.

The instruments now in use vary considerably in their principles of construction, as well as in the mechanical details; and the kind of apparatus to be applied in any particular case must depend upon the form and situation of the curve, and also upon the age of the patient.

There can be no doubt that the greatest advance which has taken place in modern times in the treatment of lateral curvature of the spine, has been made through the *system of mechanical treatment*, by means of spinal instruments; but as might have been anticipated from the novelty and importance of the system, too much has been expected from it, and also too much claimed for it by its principal advocates.

Compared with other systems, there can be no question as to the superiority of the mechanical treatment, and if one plan alone were to be adopted, this would be most entitled to our confidence; but the evidence which I have laid before you of the constitutional, as well as the local causes, which contribute to the production of spinal curvature, and the nature of the structural changes which occur even in slight cases of lateral curvature, must prevent our placing sole and implicit confidence in the power of any spinal instrument to cure the curvature.

I have no hesitation in stating, that it is impossible to straighten a curved spine by any mechanical means, in the same

manner and upon the same principle as we can straighten a bent knee, ankle, or any other movable articulation; but in combination with other means, such as partial recumbency, and in some slight cases with muscular exercises, it is quite possible to cure a curvature of the spine when slight and of recent formation in young persons; and it is certainly within our power most effectually to arrest the progress of curvature when more severe.

Note.—Mr. Barwell employs mechanical pressure by means of elastic bands, variously arranged according to the nature of the case, with the double object of affording support, and at the same time permitting free action of the muscles of the trunk. In endeavouring to carry out this treatment, he advocates the use of a “loin bandage” for curvature in the lumbar region of the spine, and an oblique bandage in dorsal curvature.* These bandages fail to afford support, because the fixed points from which they take their bearings are, in the varying movements of the body, constantly changed in their relative positions, so that although the bandage may be firm in the erect posture, it becomes displaced when the sitting position is assumed. I have also found that the oblique bandage causes constriction of the chest, and consequent interference with the act of respiration. Mr. Barwell also advises the use of a sloping seat “for lifting that side of the pelvis which is abnormally depressed;” but if the tilting of the pelvis is simply a physiological condition, resulting from inequality in the length of the legs, or from a habit of standing on one leg, it will correct itself when the individual is sitting, so that an oblique or sloping seat is unnecessary. If, moreover, the tilting of the pelvis is a persistent condition, associated with a confirmed lateral curvature, then no good whatever can result from any attempt to correct it by an inclined seat, or indeed by any other mechanical contrivance.

* *Loc cit.*

LECTURE XI.

THE TREATMENT OF LATERAL CURVATURE OF THE SPINE (CONCLUDED).

I now propose to describe in detail the treatment which will, I believe, be found most generally applicable to the various cases of lateral curvature of the spine, included in the three classes, or sub-divisions, in which I have arranged the cases of this deformity, according to the relative degrees in which they can be traced to depend upon constitutional and local causes.

FIRST CLASS.

Cases essentially of Constitutional Origin, or in which the Constitutional largely predominate over the Local Causes.

In this class of cases the spinal curvature generally occurs under twelve years of age. Many cases occur in infancy or early childhood, *i.e.*, under three or four years of age; but the majority between seven and twelve years of age.

In those which occur in Infancy, the cause seems to be general muscular and constitutional debility; the children are too feeble to sit upright, even when a year and a-half or two years old. If these children be nursed in the sitting position, and more especially if habitually carried on one arm, a posterior curvature, or general yielding of the spine, is first noticed, and subsequently a lateral curvature often produced. Now, the question is—

What treatment is best adapted to these cases? I need hardly

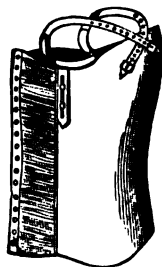
say that the constitutional treatment is of the first importance. As a general rule, these children have been badly suckled, the mother's milk being insufficient in quantity or poor in quality, or both, and farinaceous food has been substituted. But many have from birth been extremely delicate and feeble—sometimes they are seven or eight months' children—or the condition of debility may have followed some severe illness.

The most valuable remedy for improving the general health and strength in these cases is undoubtedly cod-liver oil, which I not only give internally, but order to be rubbed externally over the entire body and limbs, every night and morning after the bath, or for external application, neat's foot oil may be substituted. An abundance of good milk must be given if the child can take it, and three grains of the hypophosphite of lime may be taken in milk twice a-day; sometimes also a tea-spoonful of wine in arrowroot once or twice a-day, and fluid animal food, such as veal broth, the gravy of meat, beef-tea, jelly, &c. Solid meat is seldom well digested by these delicate children, and even when cut up very small is most improper food for infants.

Then with regard to *the local treatment*, the object of which must be either to prevent or cure a spinal curvature, the first point is, never to allow the child to be nursed in the sitting position. It must always be nursed and carried upon a pillow, or in a properly constructed nursing cradle, and the spine well supported by a strong leather spinal support, such as that which I now exhibit. (See Fig. 47.)

Essentially this support consists of a piece of thick leather, accurately moulded to the form of the back. A plaster-of-Paris cast is first taken of the back whilst the child is lying on its stomach on a table, so that, as nearly as possible, the natural form is thus represented; the leather in a moistened state is then

FIG. 47.

Mr. Adams' Spinal Support
for Infants.

placed on the cast, and allowed to dry in the proper form. Elastic india-rubber material is attached to each side of the leather support, and passes in front across the chest, where it is fastened by lacing.

For children of about two years old or more, I generally add a slight steel crutch on either side, to resist the inclination to fall forwards; but for infants a padded leather strap is sufficient to keep the shoulders back.

In a cheap form this kind of support may be imitated by a piece of gutta-percha moulded to the back, and kept bandaged on for ten minutes, whilst the child is made to lie flat on its stomach. It should then be lined with wash-leather, and retained in position by an ordinary bandage passing round the body.

The leather spinal support above represented will require to be renewed every six months, in consequence of the growth of the child, and must generally be worn during the daytime for about two years, more or less. In the more severe cases I recommend that this support be worn during the night as well as the day, if sleep be not interrupted by it.

For children from seven to twelve years of age, who are the subject of lateral curvature of the spine, I recommend the use of a light steel spinal instrument, with one or two lateral plates,

FIG. 48.



The England Spinal Support, as improved by Mr. Adams.

according to the form and situation of the curvature. The form of instrument I employ in these cases is essentially the same as that invented by the late Mr. Eagland, of London, but the lever at the back is made to move by a single cog-wheel with lateral action, and the arm-pieces should rise rather higher in front. The lever at the back is connected with the crutches by a leather strap. (See Fig. 48.)

This form of apparatus may be made extremely light, and can be worn by any child without inconvenience. The small

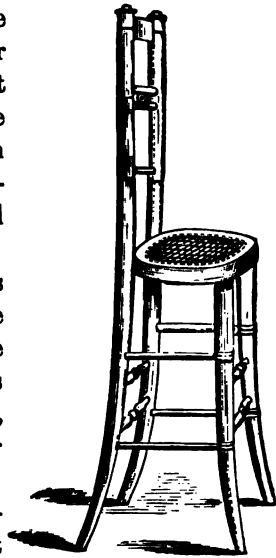
size of the hips in children renders it difficult to adapt any spinal instrument, but the form of the pelvic belt in the above apparatus is decidedly preferable to those of the other instruments in use. This instrument requires to be adjusted occasionally—that is about once a fortnight, or once a month—by the surgeon, but from the simplicity of the mechanism, any intelligent nurse can be taught to regulate it from day to day, when required. More recently I have employed the form of instrument represented in Fig 65 (*see* Appendix.)

I believe it to be quite unnecessary that this or any other form of steel apparatus should be worn at night, as recommended by some orthopædic authorities. No mechanical power can be advantageously exerted by these instruments during the night, and the mechanical cause which leads to increase of the curvature—viz., the irregular distribution of the superincumbent weight—is effectually removed by the recumbent position. The freedom from restraint also is undoubtedly advantageous to the general health and muscular strength of the child.

In the treatment of these, as well as in all other cases of spinal curvature in young persons, the long continuance of the sitting and standing positions must be avoided as much as possible, and no position is so injurious, or so likely to produce spinal curvature, as sitting upright in a perpendicular-backed chair, such as that delineated in Fig 49.

This chair, so well-known as the Astley Cooper chair, has been for many years extensively employed in educational establishments, with the idea that the position which young ladies are thus compelled to assume would either prevent them

FIG. 49.



The Astley Cooper Chair, copied from Mr. Duffin's work on the Spine, p. 50.

contracting the habit of stooping, or would overcome any such habit. The objections to the continuance of the position enforced by this chair have been ably pointed out by Mr. Duffin,* who observes, "but these and equally valid objections to the use of the chair in question are usually met by the assurance that 'Sir Astley Cooper approved of it,' and he is, indeed, generally quoted as its inventor."

The long continuance of the standing position, such as standing in classes at school, &c., is equally injurious. The fatigue induced causes the girl to vary her position by standing on one leg, which necessarily produces tilting of the pelvis; and in such a habit the foundation of spinal curvature is frequently laid.

The long continuance of the sitting and standing positions

FIG. 50.



Ward's Reclining Chair adapted for Spinal Cases, and adjustable to any angle.

are then especially to be avoided, and when the spine is weak and disposed to curve, or when curvature exists, the reclining position is that which should be enforced during at least one third of the day; and for this purpose I recommend the use of Ward's reclining chair, as shown in Fig. 50.

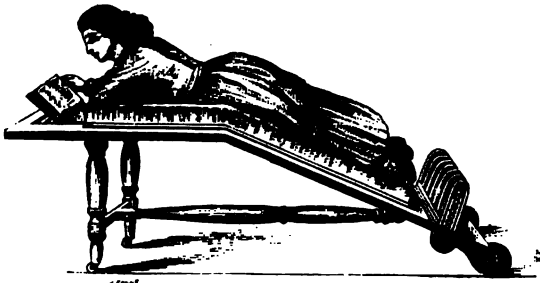
The inclination of this chair can be varied to any angle, from that of an upright chair to a horizontal couch, but the angle of

* "On Deformities of the Spine," by E. Duffin, M.D., London, 1848, p. 51.

45° or more, as represented in the woodcut, is that best adapted to long-continued recumbency for spinal cases. In this position the weight of the head and upper extremities is effectually removed from the spinal column, and the patient does not suffer any of the inconveniences, such as headache, indigestion, &c., so frequently attendant upon lying down on the *inclined plane*, or lying flat upon the floor, which formerly used to be recommended. The addition of arms and a reading-desk to the chair adds materially to the comfort of the patient, and allows education in its more important branches to proceed without interruption. This chair has been adapted to spinal cases, at my suggestion, by Mr. Ward, of Tottenham Court Road.

Partial recumbency, by which I mean reclining for about four or six hours a-day, is an essential part of the treatment in the cases we are now considering, and the use of the *prone-couch*, represented in Fig. 51, may be recommended as affording an

FIG. 51.



The Prone-Couch.

agreeable change from the reclining chair, and facilitating some branches of study, such as drawing, music, &c. In this position, also, needlework may be more freely permitted.

Muscular exercises or gymnastics should also be combined with partial recumbency and mechanical support in the treatment of the cases we are now considering, viz., those occurring in children between the ages of seven and twelve years. The gymnastic exercises form the most agreeable part of the treatment to the children, and may be chiefly relied upon

in cases in which the curvature is brought under our notice at its commencement; but if the curvature should be confirmed, then the additional use of a spinal instrument must not be dispensed with.

The gymnastic exercises upon which I believe we may chiefly rely for strengthening the spinal muscles, are those used by means of the *hand-swing*, the *elastic chest expander*, and in the *act of drawing up a weight from the ground*; the latter may be imitated by a short and strong cord of vulcanized india-rubber attached to the ground—this is the movement of the *top-sawyer* at the saw-pit. (See Fig. 52). These exercises, and any others which may be thought advisable, should be systematically gone through by the patient twice a-day, for half-an-hour each time, or a shorter period if fatigue be induced. Friction to the back and body generally, and the use of the cold-bath, when the latter can be borne, is also useful.

FIG. 52.



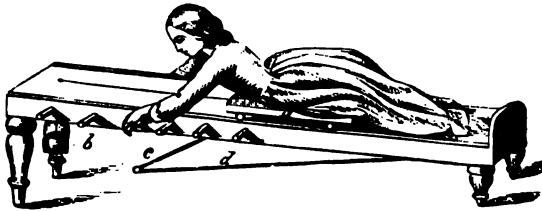
Gymnastic exercises most useful in slight cases of Lateral Curvature.

When the curvature is situated chiefly in the lumbar region, and exhibits a decided disposition to increase, the fear of which may be added to by the knowledge of an hereditary tendency to spinal curvature existing in the family, I recommend more strict attention to recumbency, and also advise the use of gymnastics in the horizontal position by means of an *exercising-plane*. These exercising-planes have been variously constructed

by Mr. Amesbury, Mr. Cost, &c., but, so far as I know, the idea was originally suggested and the plan ingeniously carried out by Mr. John Shaw,* whose treatise "On Lateral Curvature" may undoubtedly be regarded as the best and most scientific which has ever appeared in the English language.

The exercising plane I employ provides a variety of exercises both for the arms and legs, and includes some special contrivances by which the spinal muscles may be brought into play. (See Fig. 53). The body of the child when lying down on this plane rests upon a flat but softly cushioned board or stage *a*, which is made to travel up and down the length of the plane in grooves, and regulated by weight *b*, as well as by the level *c*, from which the cord *d* passes to the lower end of the plane, through a pulley to be connected with the double stage.

FIG. 53.



Exercising-plane.

Wooden handles are attached along the sides of the plane at short distances, and by grasping these alternately the child can draw up her body along the plane, and the weight to be moved, can if desired be increased by weights attached to the travelling stage.

Then, for the exercise of the legs, strong vulcanized india-rubber bands are fastened to a bar attached to the lower end of the plane, and the feet placed in shoes connected with these bands. Upon this principle a variety of exercises for the legs may be contrived, and by a similar arrangement at the upper end of the plane—a band fastened round the head and connected with an india-rubber cord—the patient may exercise

* *Op. cit.*, page 233.

the spinal muscles by drawing the head and the upper part of the body in a direction backwards and upwards, the resistance of course being the elastic force of the india-rubber band.

I here introduce a diagram, Fig. 54, of the exercising-plane suggested by Mr. John Shaw, and copied from his work, page 236, above referred to. Mr. Shaw thus describes the diagram :—

“Upon the plane A, which is considerably elevated, there is a movable board B. If the patient sits upon this and pulls upon a piece of wood attached to a cord, which, after running through a pulley F is fixed to the board B, she will draw up the board; and if the arms be at the same time kept at full length, the body must fall back in the direction of the dotted line G, thus acting upon the vertebræ

FIG. 54.

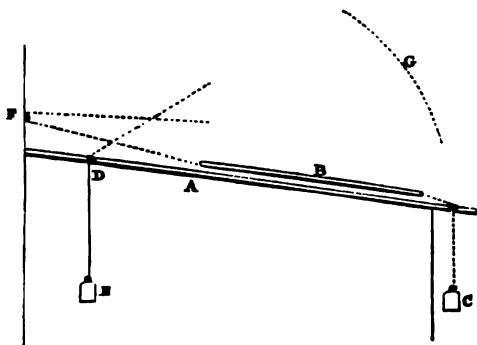


Diagram of Mr. J. Shaw's Exercising-plane.

of the loins. The power required to raise the board will depend upon the degree of the elevation of the plane, and on the weight c.

“This exercise is very good for the curve in the loins, but it produces little effect on that in the upper part of the spine. This, however, is easily effected by putting in a pulley at D, and raising the weight E with a band round the head.”

Gymnastic exercises, systematically conducted whilst the patient is in the horizontal position, possess the great advantage

of strengthening the muscles and improving the general health, at the same time that the mechanical conditions which tend to increase the curvature—and which are inseparably connected with the erect position—are completely removed. I know of no plan by which this can be so well carried out as by the use of the exercising-plane I have recommended. There can be no doubt of the great advantage of combining gymnastic exercises with the recumbent position in the treatment of lateral curvature of the spine in the lumbar region, especially when this occurs in young children, *i.e.*, between the ages of seven and twelve years, as in the class of cases we are now considering.

The same principle of treatment is no doubt equally desirable in similar cases of spinal curvature occurring at a later period, *i.e.*, generally between the ages of twelve and sixteen, as in the cases we shall next consider; but from the practical difficulties thrown in the way, especially connected with education and the indulgencies given to girls at this age, it cannot be so well followed out. I know one lady, now the mother of several children, who when young was subjected to this treatment for seven years, and passed five hours a-day on the exercising-plane. She is now perfectly straight and a good figure; but a similar tendency to spinal curvature is exhibiting itself in her daughters, who are being treated partly on a similar plan; but gymnastics in the erect position are also employed.

Too much importance cannot be attached to the treatment of spinal curvature when it occurs in children between the ages of seven and twelve years, because it is from this class that the worst cases of spinal deformity are produced. An hereditary predisposition is generally traceable, and the deformity often increases rapidly. These cases are frequently, but I believe erroneously, considered to depend upon rickets. The spine alone is affected, and there are no general indications of rickets, such as curvature of the leg-bones, or other bones of the skeleton; no enlargement of the epiphyses, no pelvic deformity, or rachitic conformation of the skull. The growth is

not stunted as in rickets; and girls thus affected often grow rapidly, and frequently attain more than the ordinary height.

Constitutionally, the general aspect of these children is decidedly strumous, and cases of phthisis may frequently be traced in their family history. There can be no doubt, therefore, that the constitutional causes largely predominate in the production of spinal curvature in these cases; hence the necessity for constitutional treatment, such as the exhibition of preparations of lime, iron, cod-liver oil, &c., and of great attention to the digestive and assimilative functions, aided by suitable residence, either at the sea-side or on elevated situations on chalk soil, &c.

These cases must be regarded essentially as the worst and most unpromising that we meet with in practice, partly on account of their own inherent tendency to increase in severity; and partly, I may say principally, on account of the difficulty met with in practice of continuing the treatment long enough either to avert the threatened mischief, or even to cure such curvature as may have already formed. It is impossible to say what length of time may be required for this purpose, but certainly in many cases treatment will require to be systematically carried out during a period of seven or ten years. In the more favourable cases three or four years may be sufficient, but much good can seldom be effected in a shorter time.

In one case belonging to this class, the young lady, then ten years of age, first came under my treatment some years ago, and the curvature although slight was confirmed; there was no appearance of rickets, but she had unquestionably a strumous aspect, and a strongly marked hereditary tendency to spinal curvature existed. Her eldest sister was frightfully deformed by a severe lateral curvature, and four of her cousins also suffered from lateral curvature. Three ladies, sisters, had each large families, and in each family there were two cases of lateral curvature.

In the case of the young lady under my care, it was a matter of great anxiety to prevent the spinal curvature becoming

severe, and if possible to cure what had taken place. I at once applied a light mechanical support, and combined gymnastics and partial recumbency. The progress was most satisfactory, and at the end of four years scarcely a trace of spinal curvature existed; no deviation in the spinous processes, and only a very slight posterior projection of the angles of the ribs on one side remained, and even this required a careful anatomical examination and comparison of the two sides to detect. The general health was good, although the girl had always a delicate appearance. At this period I recommended that the mechanical support should be gradually discontinued, and gymnastics relied upon together with partial recumbency.

I then lost sight of the case for about two years, when she was again brought to me, and a decided increase of curvature had taken place, with some lateral deviation of the spinous processes. The spinal instrument was now re-applied, and she continued to wear it for some years, till she had completed her growth; even then a slight curvature remained, but there was no obvious external deformity. During the period of increase this young lady had grown rapidly, and reached about five feet five inches in height. It is certain that in this case the mechanical support ought to have been continued through the whole period of active growth, and I mention it here to show the necessity for such prolonged treatment in this class of cases.

Next let us consider the treatment necessary in the cases which I have arranged in the second class.

SECOND CLASS.

Cases depending upon Constitutional and Local Causes in about equal degrees.

In this class of cases the spinal curvature generally occurs between the ages of twelve and sixteen years. Hereditary tendency is not usually traceable, but exists probably in about one-fourth of the cases included in this class. Muscular

debility in quickly growing girls is generally considered to be the cause of the spinal curvature in these cases, and undoubtedly in many instances muscular debility does exist, and must be regarded as the predisposing cause.

These are the cases in which girls are commonly said to have *outgrown their strength*; and we see *weak spines* gradually passing into and becoming cases of *confirmed lateral curvature*. Coexisting with these conditions, however, we may also trace, in most instances, as the direct producing cause of the spinal curvature, some local causes acting mechanically so as to disturb the equilibrium of the spinal column; such as standing upon one leg, sitting cross-legged, excessive horse exercise, and other causes already enumerated, and in the poorer classes frequently connected with certain occupations which render the long continuance of some particular position necessary.

THE TREATMENT of the cases included in this class must be, therefore, in most instances, both constitutional and local. Every effort must be made to strengthen and improve the general health of the patient where this is impaired from any cause, and for this purpose the exhibition of cod-liver oil, iron and lime, as previously mentioned, together with nutritious diet with wine or beer, amounting, in fact, to what is called *good living* where this can be borne; change of air either to the country or the sea-side and other means will generally be advisable; but *local treatment* having direct reference to the spinal curvature, is at least of equal importance with the constitutional treatment.

With this view I believe these cases require to be treated by *partial recumbency*, *gymnastic exercises*, and *mechanical support*, combined in various proportions, according to the severity and the situation of the curvature, and the general condition of the patient as to muscular debility or otherwise.

Exact rules as to the combination of these different methods of treatment can hardly be laid down, so various are the conditions presented by these cases; but, speaking generally, I recommend the *recumbent position* in the reclining chair, represented in Fig. 50, in proportion as the spinal curvature

predominates in the lumbar region. In this region the curvature is less amenable either to mechanical or gymnastic treatment; and the structural changes in the intervertebral cartilages and oblique articulating processes existing in all cases can only be arrested, and the damage repaired by the reparative powers of nature during the period of active growth in the recumbent position. All the mechanical conditions tending either to the production, or increase of the spinal curvature, are thus effectually removed; and I know of no means by which this can be accomplished except by the recumbent position.

Theoretically, therefore, complete recumbency, by which I mean lying down for a period of from one to two or three years, would be the best treatment; and practically, no doubt, it has often been found to answer exceedingly well in slight cases. The advocates of such a system will doubtless be able to point to numerous cases in which the treatment has been perfectly successful; but all practitioners know that by many patients complete recumbency for a lengthened period cannot be borne, and that under its influence the general health gives way.

A compromise must therefore be made, and there can be no doubt that, with the assistance of the improved spinal instruments now in use, the patient may be allowed to take a fair amount of walking exercise, whilst the spine is so effectually supported that the unequal distribution of the superincumbent weight—the direct cause of the increase of the curvature—is to a great extent prevented; and education as well as the ordinary pleasures of life will be much less interfered with. Writing, drawing, and music must, however, be diminished in the education of young ladies under treatment for spinal curvature, as the long continuance either of the sitting or standing positions is that which we have more especially to avoid.

The directions I usually give with respect to these accomplishments are, that all music and drawing lessons be limited to half an hour, but a young lady may practise at the piano for

half an hour at a time several times a-day ; and dancing lessons to be limited to an hour. Walking or out-door exercise should never exceed an hour at a time.

If as a general rule the sitting position be not maintained for more than half an hour at a time, and the erect position for more than an hour, with intervals of reclining of not less than half an hour or an hour, I should consider the system of partial recumbency carried out to an extent sufficient for all practical purposes in the treatment of lateral curvature.

With regard to the combination of *gymnastics* with *partial recumbency* and *mechanical support* in the treatment of these cases in which the spinal curvature predominates in the lumbar region, I believe the gymnastics should be conducted as much as possible whilst the patient is in the horizontal position, and this can be accomplished by the use of the exercising-plane, which I have already described. The patient may use this exercising-plane for a quarter or half an hour three times a-day ; it is also frequently employed as a reclining-board, so that a double object is thus effected.

Then with regard to *gymnastic exercises as a general principle of treatment* in the class of cases we are now considering, viz. : those which occur in growing girls between the ages of twelve and sixteen years, I recommend their adoption in proportion to the evidence of general muscular debility in the cases which I have described as *weak spines*, or weak spines passing into the condition of confirmed curvature ; and when the spine is disposed to curve in the dorsal and upper lumbar regions, and assume the form of a long single curve. If these cases are submitted to treatment at a sufficiently early period, gymnastics may be chiefly, if not entirely, relied upon ; but, as I regard gymnastics as a preventive rather than a curative method of treatment, I always combine with them partial recumbency, *i.e.*, lying down in the reclining-chair four or six hours a-day, which I consider to be a direct curative means.

In addition to the gymnastic exercises already described, a great variety of such means have been devised by various authors, who have paid special attention to the subject of

spinal curvature, and amongst them the following will I believe be found to be most generally useful; and first I would allude to that invented by Mr. Stafford, and described by him as "the lateral rocker." (See Fig. 55).

Mr. Stafford observes, "For the purpose of performing this exercise, I have invented a machine which consists of a semi-circle, made of wood, and which rests upon the ground, being

FIG. 55.



Mr. Stafford's "Lateral Rocker."

FIG. 56.



Exercise recommended by Mr. Lonsdale.

not unlike a rocking-horse. At the upper part, and at each end of this machine, a rope is attached which passes over two pulleys fixed at certain distances in the ceiling. The patient stands upon this machine, taking hold of the rope, by each hand, and thus rocks herself backwards and forwards, by which both the lumbar and dorsal curves are acted upon laterally."*

* *Op. cit.*, page 70.

Mr. Stafford recommended this exercise in the belief that lateral curvature was capable of being cured by lateral exercise, and observed: "When the distortion has become confirmed, when both the primary and secondary curves have taken place, when we can both see and trace with our fingers the serpentine course of the spinous points of the back, then more active treatment is required. I have found *lateral exercise* to have been of the greatest benefit in *lateral curvature*."

Whilst I do not agree, however, in the theory adverted to, and the curability of confirmed double lateral curvature by any such means, I consider the apparatus well calculated to exercise and strengthen the muscles of the spine, and therefore recommend its adoption in the class of cases we are now considering, rather as preventive than curative, although useful in cases of slight curvature, combined with other means.

My late colleague, Mr. Lonsdale,* held the same opinion as myself with regard to gymnastics being a preventive rather than a curative means, and advised their adoption either in cases of weak spine, very slight curvature, or in those cases in which "the spine has been brought by mechanical treatment nearly, if not quite, into the erect position."

In such cases his object was to strengthen those muscles "whose office it is to keep the spine erect," and especially recommended the form of exercise exhibited in Fig. 56.

Mr. Lonsdale observes,† "The wood-cut shows the position of the patient with the arms extended above and behind the head, the pulleys being placed some way behind also to ensure the most effectual action of the muscles when they draw the weights upwards, by moving the arms in the line *a b*, without bending the spine; the motion of the body being produced by the pelvis on the thigh bones.

"By this plan all the muscles of the back are put into action in the most effectual manner, including those proper to the spine itself and those connected with the ribs."

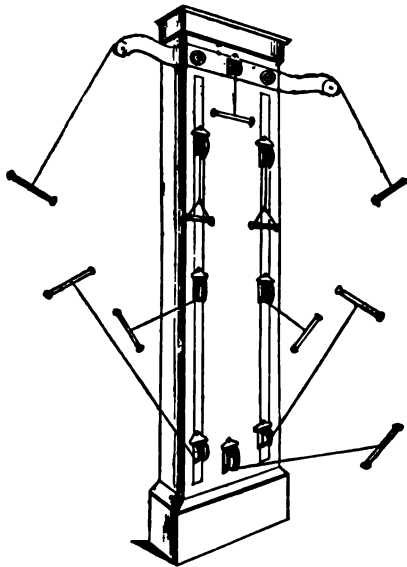
In Fig. 57 I have given a representation of a complete gymnasium, by means of which the greatest variety of exercises

* *Op. cit.*, page 116.

† *Op. cit.*, page 122.

can be performed, imitating every natural movement, and by its use capable of strengthening as far as possible any set of muscles. A number of weights are contained in the box, and to these the ropes which pass out through pulleys are connected. This apparatus is figured in Mr. Verral's work, "On the Spine,"* and is stated to have been invented by Mr. Whiting.

FIG. 57.



Gymnasium for a variety of exercises.

Instead of employing the weights and pulleys as represented in the above figure, various contrivances, consisting of vulcanized india-rubber cords, which can be attached to hooks fixed in the wall, have recently been invented, and by which every kind of exercise may be performed. Some of these have already been represented in Fig. 52, but others are exhibited in the annexed Figs. 58 and 59.

If the case, instead of being one of *weak spine*, or weak spine

* "On the Spine," by Charles Verral, 1851, page 70.

passing into confirmed curvature, be one of *confirmed curvature*, the proof of this will consist in the existence of some of the anatomical deviations which I have already described—such as the posterior projection of the angles of the ribs on one side in the dorsal region, or of the transverse processes in the lumbar region, with a corresponding depression of the ribs or transverse processes on the other side, with or without lateral deviation of the apices of the spinous processes. In such cases I believe we may safely rely upon these evidences of structural deviations as indications for the commencement of mechanical treatment, and then we must combine, with the measures just described, *mechanical support by means of a spinal instrument*.

FIG. 58.



Exercise with vulcanized India-rubber
cords.

FIG. 59.



Exercise with vulcanized India-rubber
cords.

Mechanical treatment, to be effectual, must be carried out by means of spinal instruments capable of giving a firm support to the spine, as well as exerting a certain amount of active force or pressure. This can be regulated from time to time by the surgeon, and applied with more or less accuracy to the portion of the spinal column which is the precise seat of the curvature.

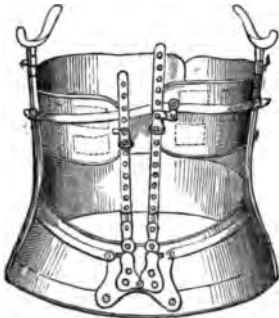
The extent to which we can rely upon *mechanical treatment* as curative, must vary very much in different cases, and depend upon the situation, form, and extent of the curvature, as well as the length of time it has existed. Speaking generally, mechanical treatment may be most certainly relied upon when the curvature predominates either in the middle or in the middle and lower portions of the dorsal region, as in these situations we can most directly act upon the spinal column through the medium of the ribs.

In the observations on the physiology of the spinal column in relation to the production of lateral curvature, contained in the second lecture, I have endeavoured to prove that lateral curvature of the spine cannot be cured by mechanical treatment alone, mainly because there is no anatomical analogy between the articulations of the vertebræ and the movable articulations of the extremities. Between the vertebræ we have no articular cartilage admitting of free surface-play, and the vertebral articulations admit only of an extremely limited amount of motion in certain directions; thus they hold an intermediate position between the movable and immovable articulations of the body. It is not possible, therefore, to straighten a spinal curvature in the same way, and upon the same principles of direct mechanical pressure or extension as we employ with so much success in the contractions of the knee, hip, elbow, and other movable articulations of the extremities.

Nevertheless there can be no doubt that of all the various *systems* employed for the cure of lateral curvature, the relative merits of which have been already discussed, if any one *system* is to be exclusively depended upon, more good will be done by the *mechanical system of treatment* than by any other, and in the more severe cases this alone must be relied upon for giving such relief as the cases admit of. But in all the slighter cases in youth a judicious combination of mechanical support, with gymnastics and lying down, according to the situation, form, and severity of the curvature, is the only scientific treatment to be relied upon in practice for curing such forms of curvature as are capable of being cured.

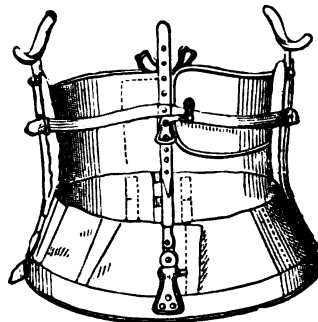
A great variety of spinal instruments, constructed upon very different principles, have been, and are still, employed by various authorities on spinal curvature; but those which I have found most efficient in the cases we are now considering, are of two forms, viz.:—one, a modification of the Eagland spinal support, adapted for slight cases in young and delicate girls (see Fig. 60), and the other, a much stronger instrument with more complicated mechanism, used in the more severe cases, and for stronger girls above fourteen years of age. (See Figs. 61 and 63).

FIG. 60.



A modification of the Eagland Spinal Instrument, with the addition of Rotation-plate for the dorsal curve.

FIG. 61.



Mr. Adams' Rotation-plate Instrument, with single plate for dorsal curve.

The light instrument, which is a modification of the Eagland spinal support, is represented in Fig. 60. The pelvic belt is strengthened by being made to clasp in front, and the arm-pieces attached to the crutches are raised in front to resist the posterior pressure. One or two steel plates are attached to separate levers, which move by cog-wheels connected with the pelvic belt in lateral and antero-posterior directions, and these levers are also connected with the crutches by means of a transverse leather strap.

The stronger instrument, which I always speak of as my *rotation-plate instrument*, is represented in modified forms with single and double plates in Figs. 61 and 63. This instrument

I have constantly used since the year 1854, when it was first made at my suggestion, for the case represented in Fig. 34, by the late Mr. Blaise, of St. James' Street. The pelvic belt is of a circular form, and made of strong flat steel; the crutches are proportionably stout, and move in an antero-posterior direction by cog-wheels connected with the pelvic belt; these, however, are only required in cases of extreme deformity. One or two lateral steel plates are attached to separate levers, the dorsal plate being made to move in several directions for the purpose of accurate adaptation, and having a cog-wheel by means of which it can be moved in the direction of horizontal rotation.

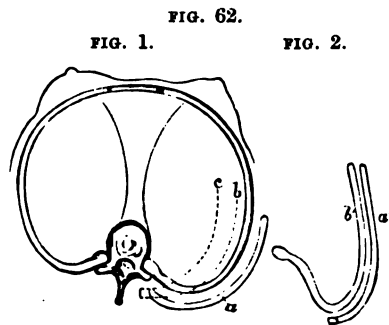


Diagram representing the action of Mr. Adams' Rotation-plate Instrument, as compared with the plates generally in use acting by direct lateral pressure. Fig. 1, Section of chest, *a*, rotation plate moving in direction of the lines *b c*. Fig. 2, *a*, plate acting in direct lateral pressure, and producing a flattening of the ribs *b*.

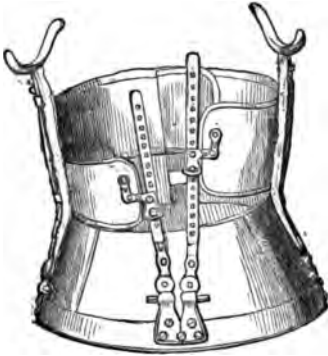
The action of this rotation-plate I have endeavoured to illustrate by the diagram in Fig. 62, as compared with the plates generally in use, acting by direct lateral pressure.

By this diagram it will be seen that the mechanical force employed by the rotation cog-wheel is directed against the ribs in the same plane, but in the opposite direction to that in which they have deviated from their normal position, in consequence of the rotation-movement of the bodies of the vertebræ.

This rotation, I believe, always takes place in cases of confirmed lateral curvature, and has been described by me as forming "*the internal curvature*," as distinguished from "*the*

external curvature," or lateral deviation of the apices of the spinous processes. The lumbar plate, shown in Fig. 63, does

FIG. 63.



Mr. Adams' Rotation-plate Instrument,
with dorsal and lumbar plates.

not generally require the same mechanism, as the force exerted by it cannot usefully be directed against the lower curve; but when this curvature involves the lower dorsal vertebræ, it may be added, as represented. The levers are movable in the antero-posterior, as well as in the lateral direction, by two cog-wheels connected with the pelvic belt, and they are also connected with the crutches by means of leather

straps, omitted in the woodcut.*

This instrument requires careful and frequent adjustment by the surgeon, who should regulate the pressure employed once or twice a week. As a general rule, I do not recommend the instrument to be worn at night, though in some cases accompanied with more than ordinary spinal pain, advantage is occasionally derived from so doing.

The cases included in the class we are now considering, viz., those which generally occur in growing girls between the ages of twelve and sixteen, and depend upon constitutional and local causes in about equal degrees, are generally the most curable we meet with in practice.

I have no hesitation in expressing my conviction that if these cases be submitted to treatment before any very obvious external deformity has occurred, they are generally curable within one or two years. In some instances, especially if an hereditary tendency to spinal curvature exists, and the girl is of feeble constitutional power, a longer period may be required; whilst in the more advanced cases the curvature cannot be

* Of late years I have usually employed the less complicated and lighter instruments represented in the Appendix, see Figs. 65, 66 and 67.

arrested or diminished by treatment in less than four or five years. In other cases it is necessary that the spinal instrument should be worn till the growth of the patient is complete, and the general health and strength sufficiently established to remove all fear of increase of the spinal curvature.

Finally, with regard to the treatment best adapted to the cases which I have arranged in the third class.

THIRD CLASS.

Cases essentially depending upon Local Causes, acting mechanically so as to disturb the Equilibrium of the Spinal Column.

Lateral curvature in these cases may occur at any period of life, though most apt to form in a severe degree previous to the completion of growth. These cases are essentially unconnected with any constitutional or hereditary predisposition, and frequently coexist with the full natural amount of muscular strength.

The local causes which directly produce spinal curvature in these cases, may be the same as those already enumerated, as contributing to the production of curvature, in conjunction with constitutional causes in the cases arranged in the second class; more especially the long continuance of some bad position acquired as a mere habit, or rendered necessary by some occupation. More frequently, however, the local cause depends upon inequality in the length of the legs, sometimes arising from congenital defects, such as congenital dislocation of one hip-joint, &c., or from contraction of the hip or knee-joint following disease, and a variety of other affections already enumerated in the classification of cases.

Boys are much more liable to spinal curvature arising from these local causes than from the constitutional causes enumerated in the other classes described.

The treatment of spinal curvature in the class of cases we are considering must be essentially local; acquired bad habits must be discontinued; occupations which tend to produce the curvature must be given up; and inequality in

the length of the legs compensated for by raising the boot on the shortened leg. In most cases the use of a spinal instrument may be recommended during the period of growth, either with the view of curing the curvature when it arises from removable causes, or of preventing its increase when the curvature has advanced to an incurable degree, and the cause producing it is incapable of removal.

The long continuance of the sitting and standing positions must be avoided; and also during growth it is necessary to combine with these measures partial recumbency, *i.e.*, the use of the reclining chair for some hours daily during the time devoted to educational pursuits.

By a judicious combination of these means, we shall thus be enabled to limit the extent of the mischief which it is beyond the power of human skill to remove.

APPENDIX.

ADDITIONAL OBSERVATIONS.

ON THE TREATMENT OF LATERAL CURVATURE OF THE SPINE
BY SAYRE'S PLASTER-OF-PARIS JACKET APPLIED DURING
SUSPENSION; THE PORO-PLASTIC FELT JACKET; OR STEEL
SPINAL SUPPORTS.

The treatment of curvature of the spine—both angular and lateral—has undergone considerable change within the last three or four years, in consequence of the method of treating these affections, introduced by Professor Sayre of New York, and fully described in his work, published in London 1877.*

This method essentially consists of the application of the principle of extension applied to the spinal column by suspension from the head, or head and arms, by which any existing curvature is more or less diminished; and 2ndly, the application of a plaster-of-Paris jacket during extension, by which the advantage gained by the extension in straightening the spinal curvature is supposed to be permanently maintained.

The originality of this method of treatment, together with the evidence in its favour which Professor Sayre adduced in his published works, and at the demonstrations given by him during his visits to this country, so strongly recommended it to the attention of the profession, that it has been very generally adopted, and there are now few surgeons who have not had opportunities of forming an opinion as to its merits.

* "Spinal Disease and Spinal Curvature," Smith, Elder & Co. London, 1877.

In the following remarks it is not my intention to discuss the subject of angular curvature of the spine, resulting from Pott's disease, but I may state as a general result of my observation, that the advantages of the plaster-of-Paris jacket are most conspicuous in this class of cases, and that my experience has led me to confirm and endorse all that Professor Sayre has claimed for it, an opinion in which I believe the profession generally will agree. The more recent introduction of the poro-plastic felt jacket, shown in Figs. 71 and 72, moulded and applied during suspension has, however, to a great extent superseded the plaster-of-Paris, and has the merit of retaining all its advantages, especially in securing rest and immobility, as well as giving a firm support to the spine, whilst its disadvantages are obviated by the facility with which the poro-plastic jacket can be removed and re-applied. But I propose to refer only to the treatment of lateral curvature of the spine, and in this class of cases my own experience and observation has led me to differ as widely from my friend Dr. Sayre, with regard to the advantages of the plaster-of-Paris jacket, as I agree with him in the class of angular curvature.

In the treatment of lateral curvature of the spine, the great practical point is, first to determine whether it is desirable to apply any form of mechanical support, and if so, what form of support is applicable to each case.

All cases of lateral curvature of the spine may for practical purposes, with reference to the principles of treatment to be adopted, be arranged in three classes, viz. :

1st. Physiological curves.

2nd. Commencing structural curves.

3rd. Confirmed structural curves.

1st class.—*The physiological curves* placed in the first class are those in which no structural changes have occurred in the intervertebral cartilages, bodies of the vertebræ, or oblique articulating processes, and commonly arise either from muscular weakness, or some faulty position, and tilting of the pelvis; as when a patient stands on one leg, or where there is irregularity

in the length of the legs from any cause, and the patient is standing without a raised boot.

Such curves disappear when the tilting of the pelvis is corrected and the patient is examined in a stooping position, with the legs together, and the head bent forward on the chest—in the ordinary position assumed by boys in the game of leap-frog—the arms should also be carried across the chest to remove the scapulæ as far as possible from the spine. In this position it will be found that the angles of the ribs on both sides in the dorsal region are symmetrical, and in the lumbar region that the transverse processes of the lumbar vertebræ are also symmetrical; there is in fact an absence of any posterior projection on one side or the other, either in the dorsal or lumbar region.

2nd class.—The *commencing structural curves* arranged in the second class form an intermediate group between the first and the third classes. In these cases the intervertebral cartilage only has suffered from unequal lateral pressure, no structural changes having occurred either in the bodies of the vertebræ or in the oblique articulating processes, such as would render the curvature permanent and persistent in all positions of the body.

In such cases, an example of which is represented in Fig. 30, the spinal curvature is much more apparent in the standing than in the stooping position, although in the latter position it does not completely disappear, as in the physiological curves; some evidence of commencing rotation is afforded, when the patient is examined in the stooping position, by a slight posterior projection of the angles of the ribs on one side, and depression on the other; and a similar deviation as regards the transverse processes in the lumbar region. The ordinary method of examining a girl in the standing position, and passing the finger down the spinous processes is utterly useless, as the commencement of rotation can only be detected in the stooping position.

In reference to the treatment, we can hardly exaggerate the importance of being able to diagnose accurately the commence-

ment of structural changes; and although as in all other classifications, sharply defined lines of demarcation are difficult to determine, and doubtful or border cases may be met with, still I believe the commencement of structural changes in the spinal column may be determined by the method I have recommended.

3rd class.—The *confirmed structural curves* arranged in the third class are those in which the intervertebral cartilages, the bodies of the vertebræ, and the oblique articulating processes have all undergone structural changes, and become adapted to the particular form of curvature produced by rotation of the bodies of the vertebræ, whether described as single or double curvatures.

In such cases when the patient is examined in the stooping position, the deviation is always increased; the angles of the ribs in the dorsal region on the convexity of the curve, bulge or project backwards, and sink in, or are depressed, on the opposite side, *i.e.*, in the concavity of the curve. Likewise in the lumbar region, the transverse processes on the convex side of the curvature project backwards, and throw into undue prominence the spinal muscles in this region; whilst on the other side in the concavity of the curve, the transverse processes are depressed, and the spinal muscles rendered less prominent. The stooping position is therefore the diagnostic test between the physiological curves in the first class, and the commencing and confirmed structural curves in the second and third classes. I am not aware that this has been observed by any other author.

Too much reliance has generally been placed upon any deviation, or otherwise, of the spinous processes; but I long since pointed out that in some cases rotation of the bodies of the vertebræ may take place to a considerable extent, and render the case hopeless and incurable, without the existence of any lateral deviation of the apices of the spinous processes. This fact was first brought to my mind by the examination of the specimen which I removed from the body of the late Dr. Gideon Mantell in the year 1852. The specimen is represented in Plates III., IV. and V.

Another illustration of the same fact, but in a comparatively slight form of curvature, is represented in the specimen figured in Plate II.

TREATMENT.—With regard to the principles of treatment in the three classes of cases I have described. In the first class, or *physiological curves*, no mechanical treatment by any form of instrument or spinal support should be employed. Reliance should be placed entirely upon physiological means, such as gymnastic exercises, partial recumbency, and attention to the general health. In cases of weak spine, the only support ever given should be ordinary stays with a little steel or extra bones down the back, and an elastic brace or shoulder-straps attached to the stays, as shown in Fig. 64; but this should be used only in cases where there is an inclination to stoop, as well as a disposition to lateral curvature.

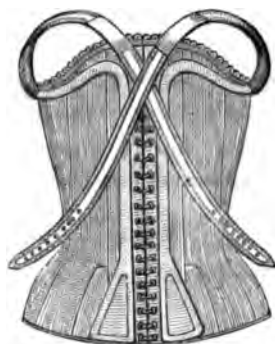


FIG. 64.

Spinal stays, with steel supports down the back, and elastic shoulder-straps. Stays and elastic brace in one.

With regard to the treatment of the cases included in the second class, and described as *commencing structural curves*—the intermediate group between the physiological and the confirmed structural curves—the importance which attaches to these cases is increased by the fact that they form the only curable class of spinal curvature; and if the progress of this affection be not checked in the early stage, it rapidly passes, in many instances, into the condition of confirmed and incurable curvature. It may be said, therefore, with much truth, that there is more to prevent than cure; but still I include in this class only such cases as those in which the commencement of rotation of the bodies of the vertebræ can be detected by the test already given.

Much difference of opinion must necessarily exist in the profession as to the treatment of the early stage of lateral curvature; and prejudice, both professional and public, against

the employment of any form of mechanical support is so great, that these cases are, and I fear will be, generally allowed to pursue their onward course to incurability.

FIG. 65.



Steel spinal support with pelvic belt and immovable spring plates attached to vertical steel bars at back.

The cases included in this class are, I believe, best treated by a combination of mechanical support, gymnastic exercises, and partial recumbency. The mechanical support may be in the form of the steel spinal instrument with spring plates, such as that shown in Fig. 65, when the cases are not likely to be under the immediate care and attention of a surgeon; but more

good will be effected by the steel spinal support with movable lever plates—see Fig. 66 and 67, applicable to cases of single

FIG. 66.



Steel spinal support with movable steel plate attached to lever; rack and pinion movements at pelvic belt. For cases of single curvature.

FIG. 67.



Steel spinal support with two movable steel plates attached to levers; rack and pinion movements at pelvic belt. For cases of double curvature.

and double curvature—if the surgeon can watch the progress of the case, and re-adjust the plates when necessary, generally

once a week or once a fortnight, so as to apply the pressure to the convexity of the curves where most required. These instruments should not be worn at night.

The plaster-of-Paris jacket, embodying as it does the principle of immobility, is inapplicable to these cases, and Professor Sayre never intended it to be applied to them, but of late it has been much employed in such cases. In private practice I have removed it in several instances from young ladies in whom I could detect only the slightest evidence of commencing lateral curvature. Neither is the poro-plastic jacket applicable to these cases.

Gymnastic exercises are especially useful in this class of cases, and should be taken both in the horizontal position, and during suspension. In the *horizontal position* the exercises are best carried out according to the system recommended by Sir Charles Bell, Mr. Shaw and Mr. Amesbury, by means of the exercising-planes represented in Figs. 53 and 54. A plane, acting upon the principle adopted by Mr. Shaw, has been made for me by Mr. Ernst. This principle is also well carried out by means of Cost's exercising-plane, in which elastic force is employed to raise the weight of the body.

During suspension, exercise by swinging on a trapeze-bar, as shown in Fig. 52, I have found to be extremely useful, and this may be taken two or three times a-day, for a quarter of an hour each time, the patient resting after every second or third swing.

In many cases, especially when the spinal curvature occurs in the dorsal region, and belongs to the class of cases described as *long single curve*, such as represented in Fig. 68, I recommend the use of a double trapeze-bar, the bars being four inches apart, one hand being placed on the upper and the other on the lower bar whilst swinging—as shown in Fig. 69. The hand placed on the upper bar should be that corresponding to the side of the body in which the concavity of the spinal curvature exists, and the effect of swinging in the position represented (see Fig. 69) will be to expand the side of the chest corresponding to the concavity of the curve, as shown in Fig. 68.

In some cases suspension by the head and arms, according to the methods recommended by Professor Sayre, and represented in Fig. 70, may be adopted with much advantage. This method, however, is but the revival of an old system, and was practised in London by Mr. Stafford more than thirty years ago, and published by him in his work on "Diseases of the Spine," in 1844, and represented in woodcut, Fig. 44.

Recumbency in these cases must be insisted upon to the extent of about one-third of the day, so that the spinal column may be so far relieved from its function of supporting the weight of the body, and admit of the free expansion of the intervertebral cartilages which have become unequally compressed. In addition to these means it is also necessary that the patient should avoid long sitting and long standing. Sitting for music lessons, &c., must be limited to half an hour at any one time; horse exercise is especially to be avoided. By this combination of physiological and mechanical treatment, I believe that such cases admit of being cured. The further progress of curvature will certainly be arrested, and the best opportunity afforded for the recovery of such slight structural damage as may have already occurred.

FIG. 68.



Figure of girl showing long single curve to the right side in dorsal region.

In the 3rd class of confirmed structural curves mechanical support of some kind must be resorted to and continued during the period of growth, with the hope of preventing increase, and obtaining some improvement in the curvature during growth; but it must be borne in mind that confirmed lateral curvature, whether slight as regards the external deformity, or severe, is essentially an incurable affection. The clearly-established pathology of confirmed lateral curvature is opposed to the idea of its curability.

There can be no hope of recovery from the adapted series of structural changes which render spinal curvature confirmed and persistent in all positions of the body. The object, therefore, must be to apply an efficient retentive spinal support, and one that can be worn with the least inconvenience to the patient;

FIG. 69.



The same girl as in Fig. 68, using double trapeze-bar, showing its effect in expanding the left side, and straightening the spine.

FIG. 70.



The same girl, as in Fig. 68, using Sayre's apparatus for self-suspension by the head and arms, showing its effect in straightening the spine.

this, I believe, will be found in the steel spinal support represented in Fig. 65, with a pelvic belt and spring plates attached to vertical steel bars at the back, and applied to the convexity of the curve in the dorsal and lumbar regions, the vertical bars being connected horizontally with the crutches to

constant use it also interferes with bathing and cleanliness, so necessary to the maintenance of the general health.

For these reasons, then, I am decidedly opposed to the use of the plaster-of-Paris jacket in cases of lateral curvature of the spine, and believe it to be as useless and injurious in this class of cases, as it is useful in cases of angular curvature. Some of the disadvantages attending its use in lateral curvature above mentioned, such as the immobility secured by it, and the firm support afforded to the spine, being positive advantages in this class of angular curvature.

FIG. 71.



Poro-plastic felt jacket—back view.

FIG. 72.



Poro-plastic felt jacket—front view.

Another form of mechanical support has been more recently introduced in the poro-plastic jacket, shown in Figs. 71 and 72, which when softened by steam is applied in the same way as the plaster-of-Paris jacket during suspension, and it appears to have all the advantages of the plaster-of-Paris jacket without its disadvantages. It is removed at night, and re-applied in the morning whilst the patient is suspended, and can be taken off at any time for the purpose of gymnastic exercises. Its restraint over the chest is much diminished, and the liability to produce sores removed by portions of the felt where necessary being left in a softened condition. It is, therefore, well calculated to act as a good, efficient, and light retentive support in many cases of incurable spinal curvature in the third class.

CASE
OF
DISTORTION OF THE SPINE.*
WITH
OBSERVATIONS ON ROTATION OF THE VERTEBRÆ AS A
COMPLICATION OF LATERAL CURVATURE.
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DEMONSTRATOR OF MORBID ANATOMY AT ST. THOMAS'S HOSPITAL.

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The late Gideon Mantell was born in the year 1790, at Lewes, in the county of Sussex. He applied himself at an early age to the exploration of the fossils of the upper chalk formation, and on coming to London to attend the medical school of Bartholomew's Hospital, he took with him a collection of considerable extent.

On his return to Lewes to engage in practice, he still continued his investigations, and it will easily be believed that his labours were great, inasmuch as his most remarkable and successful researches were carried into the Galt and Wealden rag—in the hard and untractile masses of the latter he

* From Volume XXXVII. of the "Medico-Chirurgical Transactions," published by the Royal Medical and Chirurgical Society of London, 1854. Plates III., IV. and V. are taken from this case. The specimen was also exhibited to the Society, and is now deposited in the museum of the Royal College of Surgeons. A plaster cast, taken before the section was made, and accurately representing the amount of distortion, is also in the museum. The specimen has been somewhat altered in reference to the lateral deviation of the spinous processes, and the condition of the intervertebral cartilages, by the maceration to which it was submitted for the purpose of being cleaned under water previous to being put in spirit, and also by a fresh section made through the column.

discovered the remains of those last gigantic reptiles, the *Megalosaurus* and *Iguanodon*.

Impaired health and other causes induced him to transfer his practice from Lewes to Brighton, and some time after he again moved and settled at Clapham, where his personal labours as to his favourite pursuits were restricted to the collection and examination of the few fossils to be met with in the gravelly alluvium.

It appears that in 1842, being then 52 years of age, he suffered from excessive pain in the back, inducing him to apply an opiate liniment and leeches. Then he was thrown from his carriage upon the back, and the symptoms are reported to be aggravated, and numbness came on in the left foot.

After this it is stated that he attended a case of concussion of the brain, and walked home in an intensely cold night, when the lower limbs became paralysed, and the bladder required the catheter. The rectum was also affected, and enemata were used. After many weeks the power of voluntary motion slowly returned; sensation followed with intense neuralgia. The tumour in the back rapidly increased, with supposed fluctuation. During the period of nine months, Liston, Brodie, Bright, Lawrence, Stanley, Coulson, &c., were consulted. The tumour became slowly harder, and almost disappeared. Sensation continuing to return, the tumour again became larger and harder, and the abdominal aorta was pushed forward.

The cachectic appearance of the patient led to the suspicion of the formation of a malignant tumour in connection with the bodies of the vertebræ, an idea which was subsequently abandoned.

By degrees the neuralgia became less frequent, but Gideon Mantell notes his health as broken up.

To relieve intense suffering he sometimes resorted to anodynes, but it does not appear that he ever prescribed large doses for himself. On the last occasion a dose of this kind, which is believed to have been taken on an empty stomach, produced the symptoms of narcotic poisoning, which proved fatal.

**Report of the Post-mortem Examination of Dr. Gideon Mantell,
by Mr. Wm. Adams.**

Died 10th November, 1852, æt 62. Examination of the body, 13th November.

A tall, well-developed, muscular man. As the region of the spine was the chief seat of interest, from there being a history of a tumour or swelling having existed in the left lumbar region, supposed to be dependent upon, or connected with disease of the spine, the body was first placed in the prone-position, and the dissection commenced from behind.

There was a slight fullness in the left lumbar region near to the spine, but certainly nothing amounting to a tumour. On pressure, three or four hard and prominent nodules could be felt, one above the other, situated from two to three inches to the left of the spinous processes, and on a level with them.

No lateral deviation of the spinous processes could be detected in any portion of the column. Both sides of the chest were fully and symmetrically developed. No tilting of the pelvis was apparent, though some deviation might have existed, as exact measurements were not taken, nor were the pelvic bones thoroughly exposed by dissection. It may therefore be said that the body did not present any remarkable external appearance. No obvious deformity existed. In pursuing the dissection from behind towards the abdominal cavity, it soon became apparent that the prominent nodules felt in the left lumbar region were the apices of the transverse processes of the lumbar vertebræ projecting backwards, and rising to the level of the spinous processes. The bodies of the lumbar vertebræ could also be felt projecting in an arched form, with the convexity outwards to the left side, and at first suggesting the idea of a hard tumour connected with the vertebral column. No morbid appearance presented itself in the soft tissues in this region. The subcutaneous cellular tissue and fat were everywhere perfectly healthy; the muscles were apparently quite healthy. There was no trace of any morbid growth, cysts of abscess, or of any other inflammatory process

having existed in the neighbourhood ; no thickening, adhesion, or other alteration in any of the soft tissues.

The body was now placed on the back, and the abdominal cavity was laid open in the usual way. A very severe lateral curvature of the spine to the left side in the lumbar region was now seen. The curved portion of the spine presented also a remarkably twisted appearance, from lateral rotation of the vertebræ, so that the transverse processes of the left side projected backwards, as above described, whilst those on the right side projected inwards towards the abdominal cavity. The anterior common ligaments of the spine, and the cellular tissue on the anterior and lateral aspects of the vertebræ, and also the psoæ muscles and other tissues, were in a perfectly healthy condition.

No traces of abscess or of any old inflammatory process could be found, and it being impossible that a lumbar abscess could have formed and disappeared without leaving some structural changes in the soft tissues surrounding the spine, it may confidently be asserted that no abscess ever existed.

A portion of the vertebral column, consisting of the three lower dorsal, and all the lumbar vertebræ, with a portion of the sacrum, was removed for separate examination. Viewed from its posterior aspect, the apices of the spinous processes of this portion of the spinal column are seen to present a lateral deviation to the left side, the most prominent part of which, viz., between the spinous processes of the second and third lumbar vertebræ measures rather more than half an inch from a vertical line drawn from the spinous process of the tenth dorsal vertebra to that of the first sacral bone. This distance is easily diminished to a quarter of an inch by a slight effort at straightening, and this, as above stated, was not apparent previous to its removal, though as measurement was not then adopted, it might have existed.

The bodies of the spinous processes, however, instead of passing directly backwards, incline towards the left side, so that in this aspect the sides of the spinous processes are brought into view. This deviation exists in the spinous

processes of the first, second, third and fourth lumbar vertebræ, but to a much greater extent in the second and third than in the others, the angle of lateral inclination in these being nearly 45° . The spinous process of the fifth lumbar vertebra retains its normal direction.

The transverse processes of the first, second and third lumbar vertebræ on the left side project backwards towards the skin at about an angle of 45° , and rise exactly to the level of the apices of the spinous processes. The transverse process of the fourth lumbar vertebra on the left side is very remarkably altered both in direction and form; instead of passing directly outwards, it curves upwards as a horn-like process, and approaches the transverse process of the third vertebra within three-eighths of an inch, and instead of being flattened in its antero-posterior aspects, it is compressed from above downwards and expanded horizontally towards its free extremity. This expanded portion measures three-quarters of an inch in its transverse diameter, and its under surface presents a shallow cup-like depression, coated with a thin layer of fibro-cartilaginous substance, giving to it a well-marked character of an articular surface. There can be no doubt that this transverse process rested upon the crest of the ilium, articulating with it, as it were, by its expanded extremity, the form of which, together with its altered direction, being the result of long-continued pressure from the superincumbent weight. The oblique section made through the sacrum in removing the parts, has unfortunately not included the corresponding portion of the crest of the ilium; but the above supposition is rendered exceedingly probable by the general aspect of the parts, and is also supported by the existence of a similar condition in the specimen closely resembling the present, from Mr. Cæsar Hawkins' collection at St. George's Hospital. In this preparation the pelvis is attached, the corresponding transverse process presents a precisely similar appearance, and has only been slightly separated from the crest of the ilium, upon which it obviously rested, in the process of drying. The transverse process of the fifth vertebra has been sawn through in removing the parts,

but from the portion still remaining, it must have been either absorbed to a great extent, or remarkably altered in form and position.

The transverse processes of the three upper lumbar vertebræ on the left side are widely separated from each other, whilst those on the right side are proportionately approximated. The distance between the transverse processes of the first and second lumbar vertebræ on the left side measures rather more than an inch, and between those of the second and third vertebræ one and a quarter inches. The transverse processes of the third and fourth vertebræ on the same side are remarkably approximated, in consequence of the altered form and direction of the latter above described; they are only three-eighths of an inch apart. The transverse process of the fifth vertebra has been sawn through in detaching this specimen. The distance between the transverse processes of the first and second lumbar vertebræ on the right side is only half an inch; and between those of the second and third vertebræ, and also of the third and fourth vertebræ, rather less than half an inch. The transverse processes of the fourth and fifth vertebræ on this side appear to be abnormally separated from each other to some extent, the distance between them measuring fully an inch.

The articular processes have evidently been subject to a very severe amount of irregular pressure and strain, tending towards displacement, but they have at the same time become gradually altered in form, and considerably enlarged by the growth of bone, principally at the margins of the articular surfaces, which have thus been retained in contact. These appearances are well seen in a transverse section which has been made of one of these joints. The process by which the enlargement has taken place appears to be similar to that by which the enlargement of the articular extremities of bones (in the hip and knee-joints for example) has been shown by Mr. Wm. Adams to take place in the affection called chronic rheumatic arthritis (*See* "Trans. Path. Soc.," Vol. III., 1851-1852, paper by Mr. Wm. Adams.)

Viewed from its anterior aspect, the specimen exhibits a very severe degree of lateral curvature to the left side, involving the bodies of the two lower dorsal and the three upper lumbar vertebræ, with a remarkable degree of rotation of the vertebræ in the same direction, and also a very perceptible lateral curvature to the right side, involving the bodies of the two lower lumbar vertebræ and the sacrum; so that a distinct double curvature exists. The most prominent point of the upper and larger curve is the intervertebral substance between the second and third lumbar vertebræ. If a vertical line be drawn from the centre of the tenth dorsal vertebra, and carried downwards through the centre of the sacro-lumbar articulation, it will be found that the distance between this vertical line, and the most prominent part of the lateral curve, viz., the outer border of the intervertebral substance between the second and third lumbar vertebræ, measures three and a half inches.

The deformity of the spine cannot, however, be correctly described as a direct lateral curvature, for the bodies of the first, second, third, and fourth lumbar vertebræ are also rotated in a horizontal or transverse plane towards the left side, so that the anterior surfaces of the bodies of the second and third vertebræ have a lateral, rather than an anterior aspect. The rotation in these vertebræ extends to very nearly 45° from the median plane. The eleventh and twelfth dorsal, and the first and fourth lumbar vertebræ, are also implicated in this lateral rotation. In this anterior aspect of the specimen it is also apparent that absorption of the bodies of the vertebræ in the concavities of the curves, especially of the second and third lumbar vertebræ, and also of the intervening intervertebral substance in the upper curve, and of the intervertebral substance between the fourth and fifth lumbar vertebræ in the lower curve, has taken place to a considerable extent. In these situations there is not the slightest indication of any inflammatory process having existed.

Viewed in profile, or from its lateral aspect, the natural curve of the spine in the lumbar region is seen to be reversed; and instead of presenting a convexity forwards, the three upper

lumbar vertebræ, together with the twelfth dorsal, present anteriorly a concave outline. This is not produced by any absorption or destruction of the bodies of the vertebræ anteriorly, but is evidently caused by the very remarkable degree of rotation above described, by which the natural anterior convexity in this region is made to assume a lateral position, as if the spinal column had been laterally twisted on its vertical axis, the centre of motion being fixed at the apices of the spinous processes.

A vertical section, from side to side, through the bodies of the vertebræ, exhibits the following appearances. There are no indications of any destructive disease, such as caries or necrosis, having existed in any of the vertebræ. The cancellous structure appears to be healthy in all parts. The chief alteration in the bones is a diminution in thickness of the bodies of the vertebræ in the concavity of the larger curve, the result of the absorption from unequal pressure; this chiefly affects the bodies of the second and third lumbar vertebræ, each of which is diminished a quarter of an inch on the right or concave side: these vertebræ each measure one and a quarter inch in thickness on the convex, and one inch on the concave side of the curve. The wedge-shaped form thus given, to a certain extent, is less than might have been expected from the severity of the curve externally.

The intervertebral substances between the bodies of the first and second, and of the second and third lumbar vertebræ have been, to a considerable extent, absorbed in the concavity of the curve; these cartilages each measure five-eighths of an inch on the convex, and less than a quarter of an inch on the concave side of the curve; this also is evidently the result of unequal pressure. There are no indications of ulceration having existed.

It is, therefore, obvious that the lateral curvature is chiefly dependent upon absorption of the intervertebral cartilages. The intervertebral substance between the third and fourth lumbar vertebræ is uniformly diminished in thickness to a quarter of an inch through its central portion, but expanded at

each side, where it has been free from pressure, in consequence of a certain amount of lateral sliding, or displacement of the body of the third vertebra from the fourth; the lower border of the third vertebra projects beyond the upper border of the fourth vertebra three-eighths of an inch towards the left or convex side; and on the opposite side has receded, as it were, from the edge of the fourth vertebra to a like extent. The body of the fourth lumbar vertebra, by a similar movement of lateral displacement, also projects beyond the body of the fifth vertebra three-eighths of an inch to the left side.

The intervertebral substances between the fourth and fifth lumbar vertebræ, and between the fifth vertebra and the sacrum, are diminished in thickness, in an opposite direction, to those between the second and third, and the third and fourth lumbar vertebræ. The cartilage between the fourth and fifth vertebræ measures rather less than a quarter of an inch on the left side, and rather more than three-eighths of an inch on the right side; so that it is diminished a quarter of an inch on the left side. The cartilage between the fifth vertebra and the sacrum is diminished in the same direction, but to a somewhat less extent.

The bodies of the fourth and fifth vertebræ are not diminished in thickness on either side; they both measure $1\frac{1}{8}$ inches in thickness in all parts. The wedge-like form of the last two intervertebral cartilages described, will be seen to produce a curvature to the right side, the arc of which would include the bodies of the fourth and fifth lumbar vertebræ and the first bone of the sacrum.

As minor alterations in the osseous structures, indicating a reparative process, may be mentioned a considerable increase of thickness and density of the compact structure forming the outer surface of the bodies of the vertebræ in the concavity of the curve, and also of the adjacent portion of the cancellous tissue similar to the thickening of the walls of the long bones in the concavities of the curves following rickets in early life, and no doubt answering a similar purpose of buttress-like support. The superior and inferior margins of the bodies of

the vertebræ are also enlarged so as to form projecting lip-like processes.

It was not considered advisable to lay open the spinal canal for the purpose of examining the condition of the cord, though such a proceeding might appear to be necessary to the explanation of some of the symptoms in this case. The section for this purpose could not have been made without totally destroying the specimen as one of deformity, and in this respect it presented so many features of interest and practical importance, that their preservation was considered to outweigh the chances of discovering any morbid changes in the spinal cord.

The fact of the greatest practical importance which this specimen illustrates and clearly proves, is one which I believe has not hitherto been described, viz., that a very severe degree of lateral curvature of the spine with transverse rotation of the bodies of the vertebræ, accompanied with lateral absorption of the bones and intervertebral cartilages to a considerable extent, and attended with all the distressing symptoms of the most aggravated form of this affection, may exist with only a very slight lateral deviation of the apices of the spinous processes; in short, that the severest degree of deformity of the spine may exist internally, without the usual indications in respect of the deviation of the spinous processes externally.

When it is borne in mind that all surgeons are in the habit of relying upon the relative position of the apices of the spinous processes to the median line, as an index to the existence or non-existence of lateral curvature, the importance of the fact above described cannot be over-estimated in the diagnosis of this affection. In this particular case it does not appear that any of the very eminent physicians and surgeons who examined Dr. Mantell suspected the existence of lateral curvature of the spine; and general opinion seems to have been that destructive disease existed either in the bodies of the vertebræ or intervertebral substances, and was accompanied by lumbar abscess, which one surgeon, Mr. Liston, proposed to open. The fact, however, that the supposed lumbar abscess made no

progress after the lapse of a considerable time, from one to two years, but on the contrary rather diminished, threw considerable doubt and obscurity over the case; still, in the absence of the great diagnostic symptom of lateral curvature of the spine, viz., lateral deviation of the apices of the spinous processes, this affection was not suspected; and it does not appear that the hard nodules felt in the lumbar region, and once supposed to be the lobules of a tumour connected with the bodies of the vertebræ, were at any time recognised as the transverse processes of the vertebræ. This can hardly be matter of surprise, when it is remembered that it was the only positive symptom, taken in conjunction with the general aspect and inclination of the body, by which the affection could have been diagnosed, and up to the present time such a condition has not been described as diagnostic by any authority on curvature of the spine. A careful study of the present case will, however, enable us to diagnose a similar condition in like cases, with as much certainty as if the ordinary indications were present.

The condition of the spine here described as transverse rotation of the vertebræ, the centre of motion corresponding to the apices of the spinous processes, I do not find mentioned by any modern authority on these affections; but it appears to have been observed by the late Dr. Dods, of Bath, who, so far as I know, was the first to direct the attention of the profession to the subject of rotation of the spine in lateral curvature. In the year 1824 he published a somewhat remarkable work, entitled "Pathological Observations on the Rotated or Contorted Spine, commonly called Lateral Curvature."

The author endeavoured to show that the condition generally described as a lateral curvature, was really one of transverse rotation of the vertebral column, the natural flexures of which were by this movement brought more or less into view posteriorly instead of laterally; that, in fact, as an object becomes changed in its appearance from change of position, or by varying the point of sight, so an altered position, the result of rotation of the spinal column, produces the deceptive

appearance of lateral curvature. At page 98, he observes, "It does not happen in all cases of contorted spine that the whole column is moved round; if it were so, we should have invariably the profile of its three flexures brought into view in the manner described, whereas it is well known that there are frequently but two of them observed." At page 23, he remarks, "As the spine is rotated spirally, and not as upon a pivot, the profile of its flexures will be imperfect." Dr. Dods appears to have been led to the existence of rotation by observing what was really the most positive symptom in the case now under consideration, viz., the prominence of the transverse processes in the left lumbar region. He states, page 101, "During the course of my operations (alluding to friction, &c.), upon several patients, I was struck in all of them (for they were all contorted to the right side), with a considerable bony hardness and projection on the left side of the loins, raised nearly to a level with the spinous processes, and this I found to be the case in the patients whose spine exhibited *little or no apparent curvature in the loins*, as well as in those in whom the apparent curvature was very great." After the muscles had been relaxed by friction, Dr. Dods was enabled to satisfy himself that the bony prominences were produced by the transverse processes of the lumbar vertebræ, which could be distinctly felt and counted like the spinous processes. In these cases the transverse processes of the same vertebræ on the opposite side could not be felt, and appeared to have sunk inwards completely out of reach. Reasoning upon these facts, and considering that a direct lateral curvature of the column could only affect the transverse processes by separating them on one side, and approximating them on the other, without altering their transversity with respect to the body, Dr. Dods concluded that such a condition could only be produced by a movement of transverse rotation. He also traced a similar condition in the dorsal region, evidenced by the oblique position of the spinous processes, also described in Dr. Mantell's case, and considers the rotation sometimes to extend to the cervical region.

From the above observations it would appear that Dr. Dods had met with and recognised the precise conditions now described in the specimen under consideration, for he specially mentions the fact, in some cases, of the transverse processes rising to the level of the spinous processes in the lumbar region, with "little or no apparent curvature in the loins;" and we have thought the evidence of this fact of sufficient importance to justify his views being brought under the notice of this Society. They are evidently the result of careful and original observation, though the explanation of the phenomena observed, their mode of production, and the indications for, and methods of treatment given, are in many respects erroneous, like the great majority of pathological doctrines tested by the experience of thirty years scientific inquiry; it would, however, be out of place to advert to these points in the present communication.

In the cases alluded to by Dr. Dods, his attention was probably directed to the existence of rotation in the lumbar vertebræ by prominence of one of the shoulders, and other points of defective symmetry which may or may not have existed in Dr. Mantell during life, though not obvious after death. By some it has been remarked that "he looked as if he suffered from curvature of the spine." There is no account, however, of any examination having been made with special reference to this point. From an observation made by Sir B. Brodie, in a clinical lecture delivered by him in December, 1846, and published in the "London Medical Gazette," it would appear that M. Guérin was familiar with the appearances described in the specimen exhibited. Sir B. Brodie observes, "At a very early period, and even before the lateral curvature is very distinct posteriorly, the bodies of the vertebræ are actually twisted to one side. This curious circumstance was pointed out to me by M. Guérin, who has some preparations in which the fact is very perceptible." In M. Guérin's first memoir, "On the Treatment of the Deviations of the Spine by Section of the Muscles of the Back," published in 1843, page 18, he alludes to the modifications of form dependent

upon the double influence of vertical displacement caused by lateral flexion, and of horizontal displacement caused by torsion. He was evidently aware of the existence of rotation, but does not allude to it as at any time coexisting with an absence of lateral deviation of the apices of the spinous processes, as in the present instance, or as occurring in the early stage of lateral curvature, and therefore it is not mentioned in its most important practical bearing upon the diagnosis of lateral curvature, and in proof of the existence of structural alterations, in cases of slight curvature. He had probably noticed what may now be described as the disproportion between the internal and external curvatures, also a most important fact, and one of frequent if not constant occurrence in all the more severe forms of lateral curvature of the spine.

Rotation of the vertebræ, or a spirally twisted condition of the vertebral column, as a complication of lateral curvature, is alluded to by many English writers on this affection, but generally only as a passing observation, little or no practical importance being attached to it, and by several of the principal authorities of the present day it is altogether omitted. There can be no doubt, however, of its frequent, if, indeed, it may not be said its constant occurrence as a complication of the more severe forms of lateral curvature; and when it exists in any considerable degree, it constitutes one of the chief difficulties of treatment. All the instruments at present so generally used, which make direct lateral pressure on the convexity of the curve, must tend to increase the mischief in such cases, though by their effect in flattening the ribs, this result may not at first sight be apparent.

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